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Fostering Innovation and Intrapreneurship in an R&D Organization

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PREFACE

This publication, prepared under Code 82 internal funding, presents an abridged version of the author's 1994 thesis for the MBA degree from MIT's Sloan School of Management.

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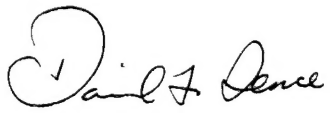

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Innovation is an important source of competitive advantage essential to organizations engaged in research and development of technology and systems. Because innovation relies on entrepreneurship to complete the technology-market link, entrepreneurship is a key source of competitive advantage. The dichotomy between entrepreneurship and central strategic planning reveals itself at all levels of an organization, especially in large, high-technology R&D organizations. On one side, the nurturing of entrepreneurship implies the need to be free of constraints; on the other, central strategic planning dictates the accomplishments of specific goals and measurable milestones. To promote internal entrepreneurship (thus, the term "intrapreneurship"), a large organization must be fully aware of the barriers to entrepreneurship and understand their impact on the effectiveness of the organization.

The primary goal of this study was to bring about a better understanding of barriers to intrapreneurship in an R&D organization by examining the origins of the barriers. A secondary goal was to identify ways to overcome these barriers and to promote intrapreneurship in management of research and development. Only the endogenous barriers—i.e., those between the innovators-intrapreneurs and organization management—are addressed in this study. An analytic framework based on an extension of earlier works was developed and, from that framework, a survey questionnaire was formulated. The survey employed a "dual-viewpoint" approach; i.e., instead of focusing on intrapreneurs alone, the survey responses from both management and the intrapreneurs viewpoints were formulated and analyzed in concert to pinpoint the causes and symptoms of barriers and corresponding possible solutions. The questionnaire was sent to 300 employees of a Navy technology and systems development laboratory in January 1994. Responses were analyzed in terms of statistical results and causal relationship between barriers and their origins. The tension factors between groups with a high tendency toward either innovation or maintaining the status quo were established, and these factors were found to be consistent with contrasts in values and norms between the two groups and were found to originate from the fear of change. The principal products of this study are a prioritized list of major innovation barriers and identification of the tension factors that created the barriers. The intrapreneurship concept formalized by Edward Roberts is applied to formulate a prototype program to overcome innovation barriers.

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Table of Contents

List of Illustrations

List of Tables

Fostering Innovation and Intrapreneurship in an R&D Organization

1. Introduction

In a world of constant change, products in the world market place derive less and less of their value from production labor or capital goods and more and more from the quality of thought and innovation imparted to the products. As certainty in the market place diminishes, accelerated and more encompassing innovation has become as important as increasing productivity.

Experience shows that successful companies are those that have initiated innovative changes in technology, marketing, or organization and, as a result, generated a competitive advantage. Technological innovation can provide the potential for altering the competitiveness of firms—and nations as well. Leaders of all organizations know that they must support people who have ideas and who display initiative—the entrepreneurs—because they are agents of change and our hope for the future. To retain vitality as it matures, an organization must build in a capacity for innovation self-renewal or a framework within which continuous innovation renewal can occur. Through a higher awareness of the barriers to innovation and their origins, organizations may be better able to overcome those barriers and to change and renew their sources of innovation.

Entrepreneurs are needed not only to start new business ventures, but also to put life back into existing companies, especially large ones. As was pointed out by Pinchot (1985), the vigor of our entrepreneurial spirit is one of the United States' greatest business treasures. Owing to a heterogeneous culture and an inclination to challenge authority, and reinforced by a spirit of self-reliance, adventure, and willingness to try new ideas, Americans have a full measure of the entrepreneurial spirit. How to harness that spirit and transform it into core competence and competitive advantage is the challenge for all leaders.

The main goal of this study was to synthesize previous work into a framework that helps bring about a better understanding of barriers to innovation and intrapreneurship in an R&D organization. A secondary goal was to identify ways to overcome these barriers and promote intrapreneurship in strategic management of research and development. The approaches were primarily descriptive, inductive, and semi-quantitative. By nature of the triadic relationship among innovator-intrapreneur, organization-management, and market environment, Piatier (1984) categorized barriers between organization and market environment as exogenous barriers, while those between innovator-intrapreneur and organization-management he termed endogenous barriers. Only endogenous barriers were investigated in this study.

2. Literature Review and Conceptual Background

Invention and Innovation

An invention refers to a new discovery proven to work, while an innovation is the process of converting ideas into widespread applications. Roberts (1987) gave the general definition: innovation = invention + exploitation. In his book on innovation and entrepreneurship, Martin (1984) compared the various theoretical frameworks of the innovation process. For example, Bright (1969) divided a technological innovation process into eight overlapping phases: discovery, theory or design concept, verification, breadboard model, prototyping, commercial introduction, widespread adoption of innovation, and proliferation. A clear distinction was made between invention and innovation: a scientific invention is a new idea or concept generated by research and development; this invention becomes an innovation only when it is transformed into a socially usable product.

Innovation is initiated and enacted through the wisdom, insight, and efforts of a team of talented human beings. Studies of innovation cannot be complete without relating the processes of innovation and creative thinking. Hudson (1966) dissected creative thinking into divergent and convergent thinking. Divergent thinking is nonlogical, nonanalytical, intuitive, and usually benefits from breaking dominant constraints. Convergent thinking, however, is logical, analytical, systematic, and introduces constraints from the relevance and practical points of view.

Kuhn (1963) suggested that the "essential tension" between convergent and divergent thinking is the source of creative ideas. Koestler (1969) postulated that the act of creation consists of the novel association of two previously unrelated concepts or ideas by "bisociation"—an act of synthesizing two frames of conceptual patterns to form a new perceptual pattern. In contrast to divergent thinking, convergent thinking filters ideas through relevance tests, cross-impact tests, and attribute and value analyses to down-scope options. These basic elements are summarized in Figure 2.1. General observation of this schematic has special meaning for two of themany innovation barriers to be discussed later, namely, the noncreative working environment and communications barriers.

Entrepreneur and Intrapreneur

Roberts (1968) emphasized that brilliant ideas do not move themselves to the market place. His data identified several entrepreneurial attributes to be: extraordinary energy to cope with indifference and resistance; persistence and courage of heroic quality; strong sense of commitment (i.e., a strong product champion, the central figure); median age of about 36 years; master of science education level; no relationship between good grades in college and successful entrepreneurship; major work experience in research and development; development oriented versus research oriented; high need for achievement; and moderate, not high, need for power. Williamson (1974) suggested 10 characteristics of an entrepreneur: superior conceptual and problem-solving abilities, broad generalist thinking, high self-confidence, strong drive, basic need to control and direct, willingness to take moderate risks, very realistic viewpoint, moderate interpersonal skills, sufficient emotional stability, tolerance of anxiety, and good physical health. Shapero (1978) found that many entrepreneurs go through a "free choice period," i.e., from 27 to 37 years old, during which they experience relatively few constraints and act to form new businesses. Quinn (1979) observed nine characteristics of entrepreneurs: fanatic commitment, chaos acceptance, low early costs (entrepreneurs invent to avoid costs), no detailed controls, low risk perceived, long time horizons, flexible financial support not bound by inflexible bureaucracies of large organizations, multiple competing approaches, and market need orientation.

Pinchot (1985) compiled a self-test of 12 questions to determine if a person has entrepreneurial tendencies. These questions can be condensed into the following qualifying entrepreneurial characteristics: A perfectionist tendency, an ability to conceptualize ways to realize a new idea, self-confidence and courage, an inclination to do things that exceed one's authority, a willingness to try out ideas even when the chances of failure are clear while rewards for success are unclear.

Historically, entrepreneurs leave large firms, where new technologies were created, to set up small firms to exploit the new technology that they felt they were constrained to pursue in the large firms. As Roberts (1968) first noted, as well as Roberts and Frohman (1972) and later Pinchot (1985), intrapreneurship is a method of harnessing the entrepreneurial spirit where many of the country's best people and resources are located; i.e., in large organizations. Pinchot gave the following definition of intrapreneurs: those who take hands-on responsibility for creating innovation of any kind within an organization. The intrapreneur may be the creator or inventor but is always the visionary who pursues how to turn an idea into a profitable reality. Roberts (1968) found a close match between the attributes of internal and outside entrepreneurs.

Innovator and intrapreneur are often confused. The definition of innovator and intrapreneur can best be illustrated by a business life cycle diagram (Figure 2.2). Such a diagram was given in a primitive form by Pinchot; it has been enhanced here and expanded to include Bright's eight phases and Sahal's (1981) step-wise improvement renewal cycle.

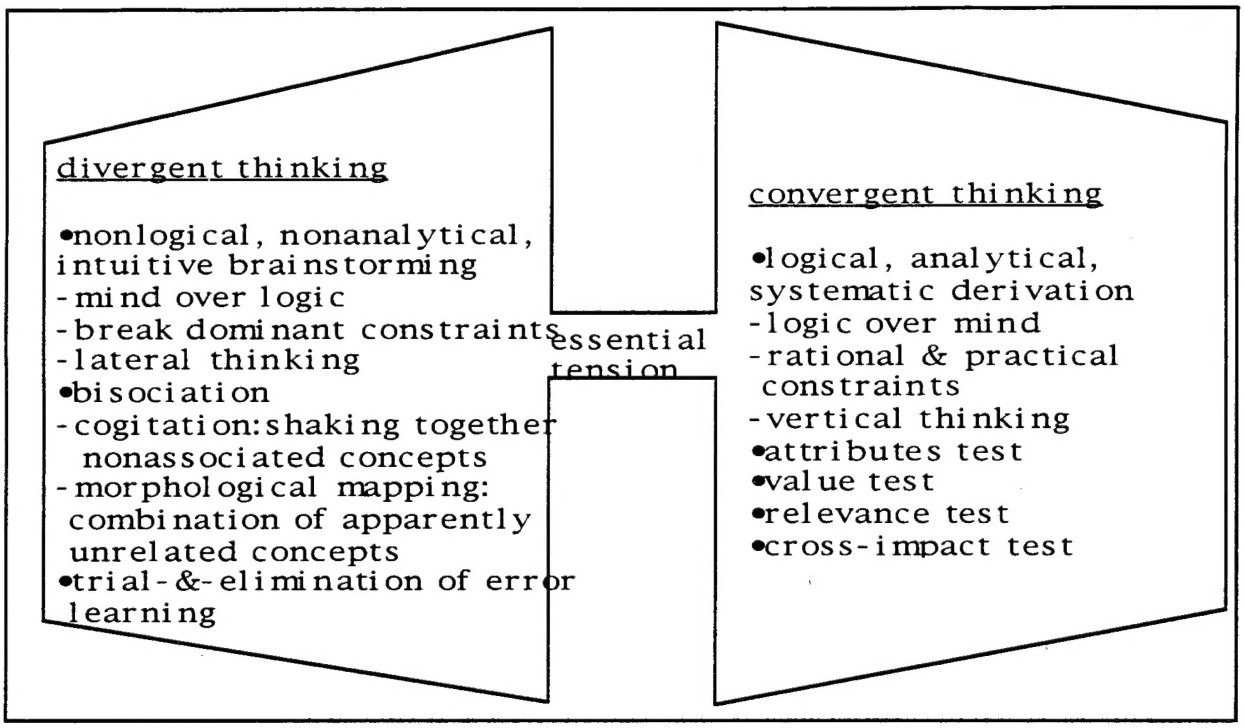

Figure 2.1. Basic Elements in Creative Thinking Process Based on Kuhn (1963), Green (1964), Koestler (1969), and Martin (1984)

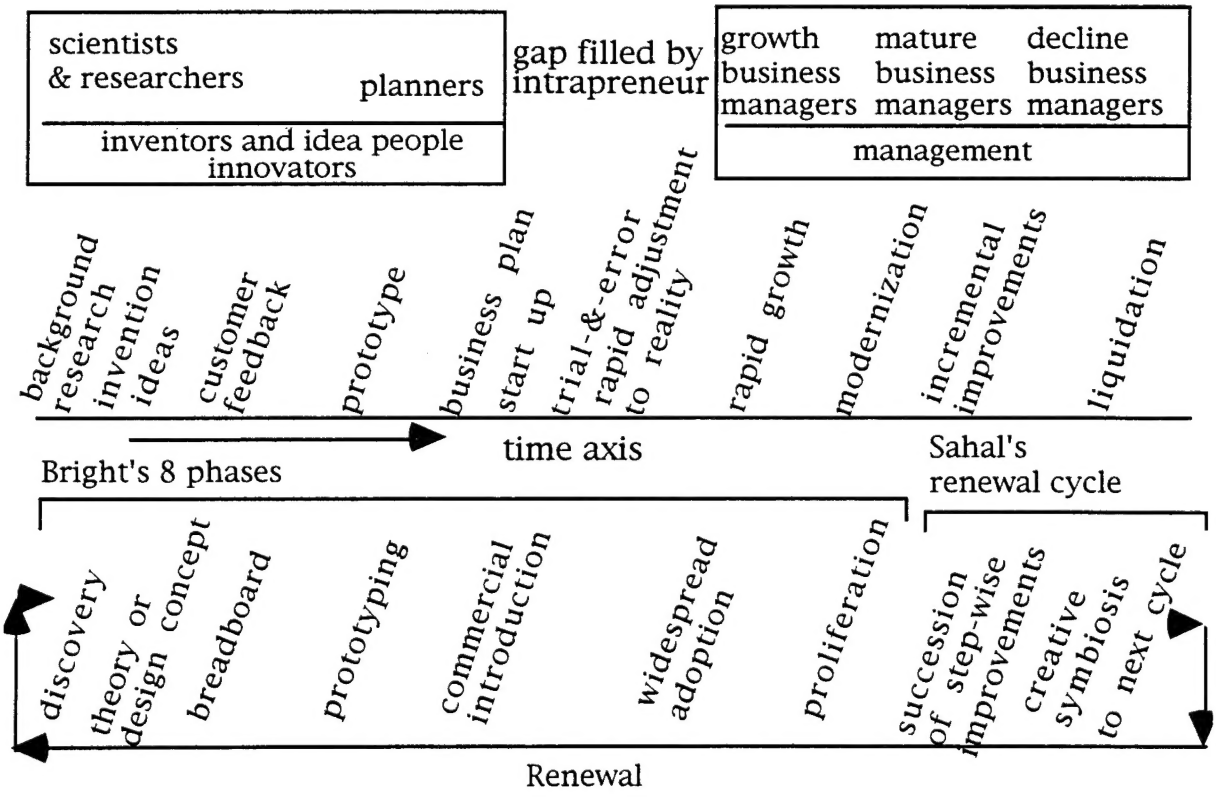

Figure 2.2. Roles of Innovator and Intrapreneur in a Business Cycle

As indicated in Figure 2.2, the difference between innovator and intrapreneur lies in both the timing and functions they serve during the innovation process. Once a prototype has been completed, the innovator starts conducting market research or attempts linking technology and market; at that moment, the innovator crosses the threshold from innovator to intrapreneur. The intrapreneur is not necessarily the innovator, but someone who recognizes the potential of innovation and is willing to commit all resources to materialize its potential. Intrapreneurs almost always do their own market research and are generally more thorough and more effective in finding new markets than are uninvolved marketers. This entrepreneurial passion was once considered " a lack of objectivity" but is now understood as "commitment." This quality of commitment is a key indicator of entrepreneurial tendency. Empirically, venture capitalists' selection criteria put emphasis on investing in entrepreneurs instead of entrepreneurs' business plans, since over time a business plan changes more rapidly than does an entrepreneur's character.

Innovator's and Entrepreneur's Values, Needs, and Growth Patterns versus Organization's Values and Needs

Boksjo and Delin (1991) contrasted the values and norms of an entrepreneur and those of an organization where an entrepreneur resides. Quinn (1979) analyzed innovators' behaviors and summarized them in nine elements. One salient element is that the entrepreneur's loyalties are to the idea and its success, not to promotion in a vertical organization. Quinn (1979) highlighted the contrast in values and norms between an entrepreneur and an organization. His results can be condensed into three key contrasts: freedom versus hierarchical order in organization, flexible plan versus detailed control, risk reward versus penalty, i.e., organizations do not penalize for missed opportunities or underinvestment in nonmeasurable areas, such as skill development and technological innovation. The essential findings of Roberts (1968), Pinchot (1985), Quinn (1979), and others are synthesized and presented in Figure 2.3, which shows the key differences between an intrapreneur and the organization. The intrapreneur values vision (future), creativity (beyond the set plan), autonomy(willingness to take risk), and flexibility(beyond organizational structure). The organization values efficiency (present) and problem solving (convergent thinking) and demands order and control. These differences are highlighted and the tension factors are summarized at the bottom of Figure 2.3.

Given the above information, rewards for intrapreneurs would have to include intangibles more directly related to intrapreneurial needs. In other words, in addition to tangible compensation, the rewards must include (1) autonomy with challenge (i.e., empowerment to act, innovate, take risks, and achieve high goals), (2) flexibility (i.e., trust and commitment to explore, learn, and adapt), and (3) future-orientation (i.e., opportunities to be involved in the strategic planning process).

Barriers Along Entrepreneur's Growth Path and Origins of Barriers

The origins of barriers can sometimes be traced to theoretical criteria for evaluating innovation. Martin (1984) summarized the criteria into five categories: technological feasibility; commercial feasibility; social accpetance of any health, safety, and environmental impacts; supportiveness of relevant government policies; and, finally, congruency with corporate objectives and goals. Boksjo and Delin (1991) identified the origins of the barriers to be the differences in mental attitudes, behavior, and styles accumulated from organizational culture, while Carey, Michaelis, and Collier (1973) gave origins from nine different functional and behavioral perspectives. Rogers (1983) identified five criteria that may influence the rate of adoption of an innovation: relative advantage over the idea it supersedes, compatibility with existing values, complexity to understand and use, trialability on a limited basis, and observability by others. Rappa (1993) illustrated an obstacle due to the systemic nature of an innovation; in other words, the innovation must function smoothly with many of a large and widely distributed system of technologies and organizations for it to be considered appropriate.

Roberts (1968) identified important organizational policies and attitudes that tend toward defeating entrepreneurial efforts; these include bias against younger personnel taking on venture responsibility, less encouragement of and less latitude for independent action, less say in judgmental criteria for the venture, less cooperation between a venture and the company, difficulty in securing capital

support, and lower sponsorship. Roberts (1968) also found a longer time lag between technical idea inception and venture initiation, and that the farther the decision-maker was from the entrepreneur, the more likely the new idea or venture would be terminated. He also found barriers in the organizational decision-making process: decision-makers may not fully understand the value of the idea, especially if they have backgrounds different from that of the entrepreneur; decision-makers are too concerned with the progress of their own ideas and with the tortuous journey up the organizational ladder. Major syndromes of firms' policy defeating entrepreneurs are: use of short-term-oriented criteria for resource allocation; biased organizational belief, reward, and penalty systems that discourage risk-taking; hiring practices that rely on academic credentials and technical qualifications versus entrepreneurial characteristics.

In their study conducted for the National Science Foundation, Carey, Michaelis, and Collier (1973) identified and examined barriers to technological innovation in industry and suggested public policy options for overcoming these barriers. Although their recommendations primarily focused on public policy such as antitrust and venture capital considerations, their survey and interview methodology revealed that by far the most significant barriers fell in the behavioral and organizational category. They included: threat to individual positions in the

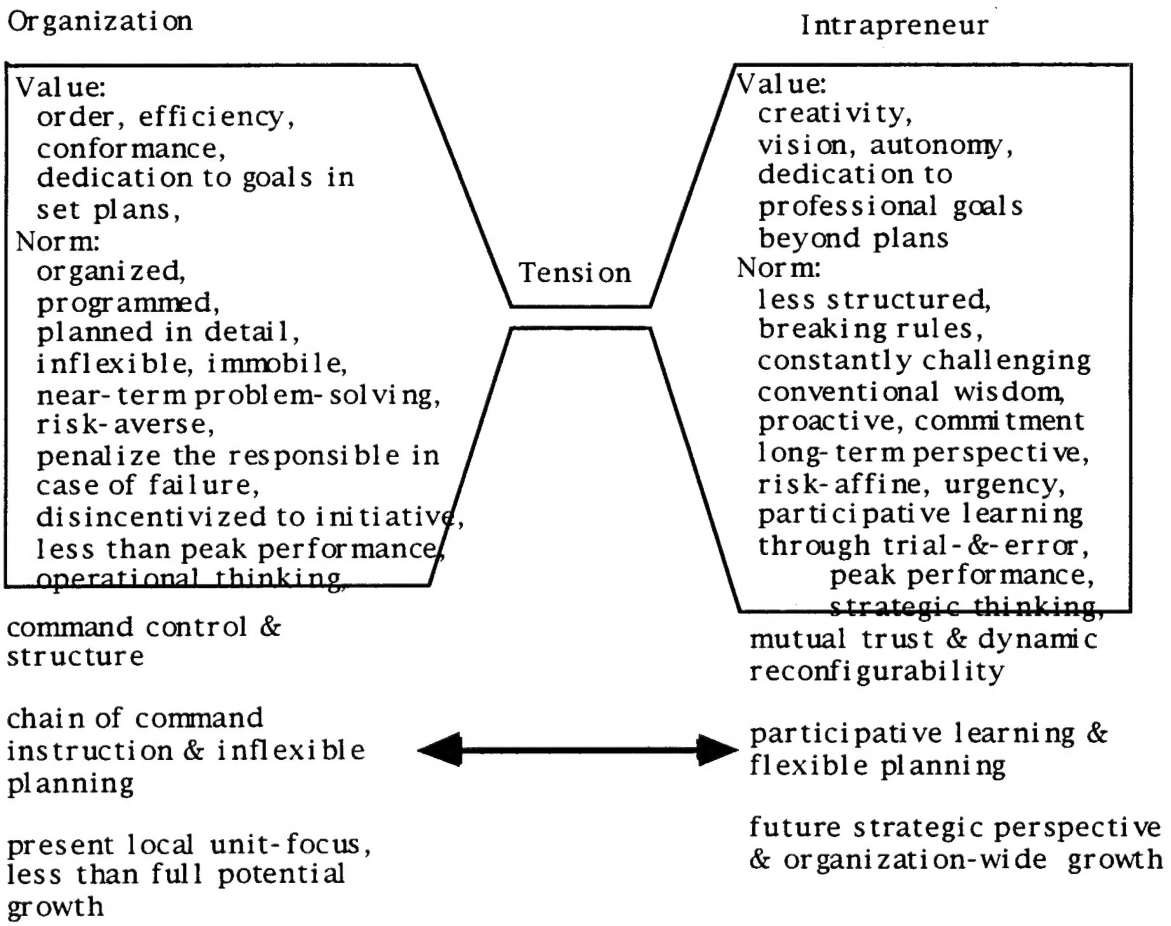

Figure 2.3. Contrast in Values and Norms Between Intrapreneurs and the Status-Quo Group and Resulting Tension

hierarchy, high individual risk of being blamed for failure, reluctance to enter new businesses due to unfamiliarity, and functional specialists having inadequate understanding of other functions. The next significant barriers were found in the corporate strategy and policy category, i.e., company management has a predominant commitment to exploitation of current products, markets, and resources; unavailability of information critical to decision-making; cost of gaining market acceptance too high; and insufficient R&D funding.

By far, Carey, Michaelis, and Collier's was the most comprehensive study of the subject of innovation barriers. Their questionnaire was structured toward nine different perspectives: behavioral and organizational, corporate strategy and policy, general management, technical, production, marketing, finance, technology transfer, and government policies. These categories are consistent with Martin's (1984) five innovation evaluation criteria. Because their focus was on government policy toward entrepreneurship, their survey can be considered to be macro in nature, or exogenous. They made no effort to look into the micro (endogenous) aspect to understand the root cause of the barriers; therefore, they did not add to existing insight as to how to eliminate barriers at the organizational level. Piatier's (1984) book on barriers to innovation deals exclusively with governmental and societal barriers to technological innovation, such as regulatory policies, consumer and environmental regulations, patent laws, and antitrust laws. Piatier examined the innovation process, barriers to innovation, attributes of innovative enterprises, adverse impact of barriers on innovative activities, routes of innovations, innovation strategy, and possible actions to increase innovation, but his comprehensive study of the subject also focused on the exogenous aspects.

Arthur Young's (1985) survey summarizes major factors that discourage innovation; these factors are the fear of failure or risk-taking, cumbersome decision structure or process, lack of funds for innovation, and preoccupation with current operations. Major factors that encourage innovation are improved market research; top management commitment, support, and leadership; reward for innovation; and risk-taking.

On interorganizational and intra-organizational communications as a barrier to innovation, Allen (1984 and 1990) indicated the difficulty originates from the underlying difference in the "local" nature of technology innovation versus the "universal" nature of scientific innovation. While scientists can communicate with each other across organizational boundaries without difficulty, technologists found it difficult to do the same because their value is defined in terms of the business goals, strategy, and culture of their organization. Allen (1984) indicated the effectiveness of the "technological gatekeeper," who is well versed technically, and the "boundary spanner," who has been transferred between organizations and understands the values of both organizations, in breaking down the barrier of communications. Allen (1990) also showed the separation of physical location of organizations to be a major barrier. These analyses appear to focus on only two (viz., technological and commercial feasibility) of Martin's five evaluation criteria.

Interdepartmental collaboration is crucial to a successful product innovation, especially in terms of the needs of speedily linking the technology to the market. Dougherty (1989) investigated the origin of "interpretive" barriers to successful product innovation. She found that interpretive barriers arise from the qualitatively different understandings of the need to collaborate with another part of organization and the established routines for product development. Dougherty found that successful product development teams violated the established routines, while unsuccessful ones followed established routines. The successful new product developers had more knowledge and gained faster insight into a wider array of issues than did the unsuccessful ones.

Based on this basic understanding, the primary barriers to innovation and intrapreneurship are captured in Figure 2.4, which serves to delineate the major barriers at different stages of the innovation relative to the organization, corporate goals, perception of risk, and availability of resources. The four phases as shown in this sketch are built on the logical evolution of innovation and observed phases by Pinchot (1985).

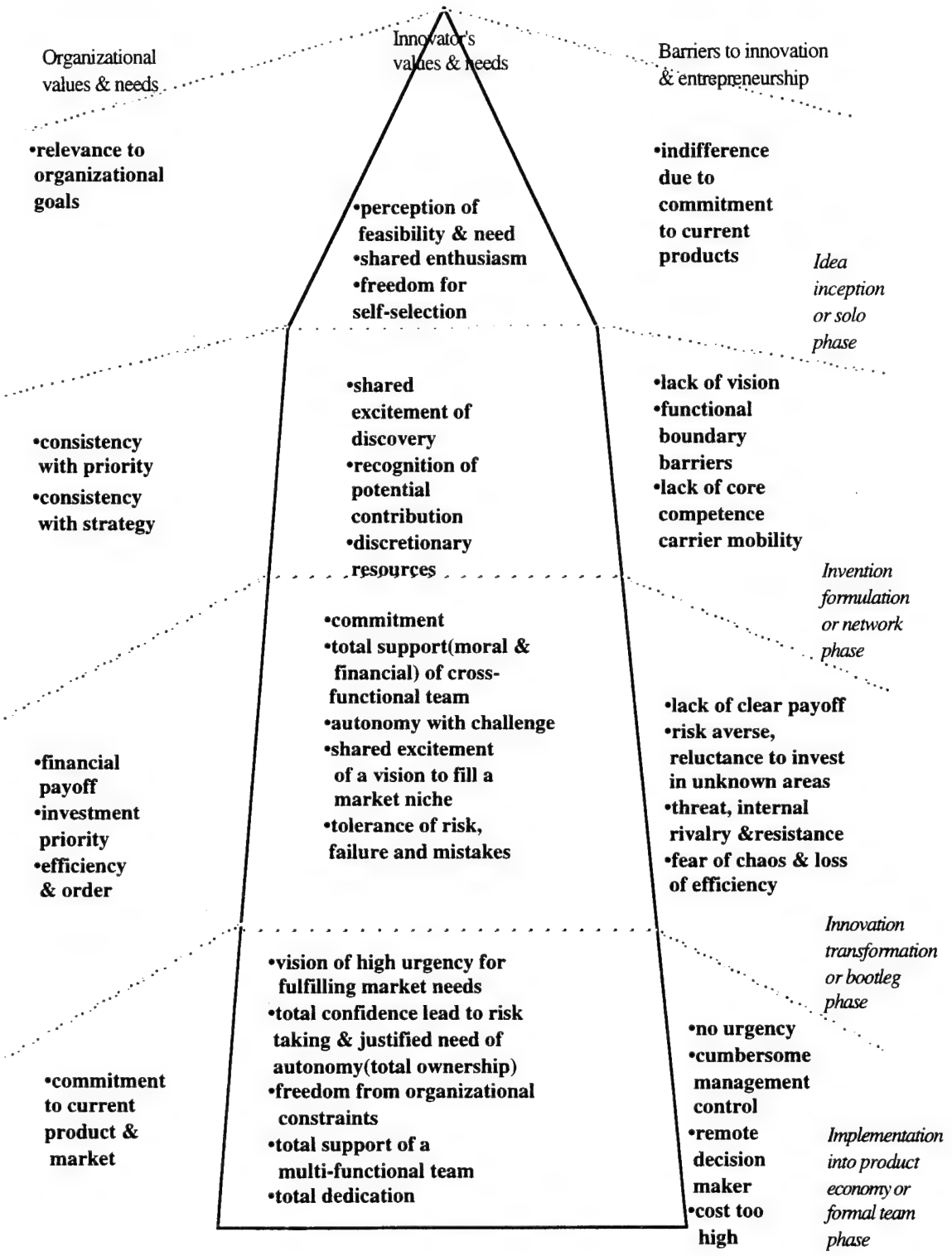

Figure 2.4. Conceptual Illustration of Barriers Resulting from Tension Between Organization's and Entrepreneur's Values and Needs at Different Stages of Entrepreneur's Growth Pattern

Despite diverse viewpoints and conclusions by various studies reported in the literature, all the observations of barrier origins can be consolidated into a single framework. This framework is based on the observation that there are two major categories of origins: the behavioral and organizational culture origin and the corporate policy, strategy, and management origin. A synopsis of the primary barriers to innovation and intrapreneurship based on the literature review is provided below.

Barriers of Behavioral and Organizational Culture Origin. These barriers to innovation include the following:

- The proposed innovation poses a threat to individual positions and the existing power structure:
  - -incompatibility with organizational values or culture norms
  - -outside scope of organization
  - -exposure of organizational lethargy
  - -potential to dislocate a continuing profitable operation
  - -internal rivalry
  - -threat to internal equilibrium of interests
  - -upsetting of evolved routines and planning mechanisms.

- A high individual risk exists of being blamed for possible failure of the innovation attempt:
  - -perceived high risk due to impossibility of reliable prediction
  - -inadequate incentives for taking risks
  - -incentives based on short-term results
  - -challenging established conventional wisdom
  - -reflection of establishment's short-term view
  - -breaking organizational rules.

- A reluctance exists to enter new fields or new businesses due to unfamiliarity:
  - -need to overcome the "collective wisdom about what business we are in"
  - -need to convince management to invest in facility and infrastructure
  - -zero-sum game in discretionary resources
  - -low expectation of obtaining resources for a new venture
  - -perceived difficulty in obtaining top-management approval
  - -unwilling to take proactive extra efforts to pursue new innovation
  - -new product is inconsistent with current product development criteria.

Barriers of Corporate Policy, Strategy, and Management Origin. This group of barriers to innovation includes:

- The predominant commitment is to the exploitation of current products, markets, and resources:
  - -too narrow a view of the market the organization serves, e.g., an oil company should view itself as energy company instead of an oil company
  - -too focused a perspective on the local organizational unit instead of organization-wide strategic growth
  - -too near-sighted or short-term focus
  - -insufficient discretionary investment funding
  - -lack of organizational flexibility to exploit new opportunities; in other words, lack of ability to reorganize itself in response to the changing environment.

- Other information critical to decision-making is unavailable:
  - -lack of opportunities for decision-makers to learn from innovators (in the literature, this is called lack of participative learning)
  - -the farther away the decision-maker is from the innovator, the more insurmountable the barrier, especially if the decision-maker does not have the same technical background as the innovator
  - -corporate decision-making process is too sluggish; time lag between technical idea inception and venture initiation increases the severity of barrier
  - -lack of understanding of innovation due to inadequate lateral and vertical communications resulting from separation of physical location.

- Functional specialists have inadequate understanding of other functions:
  -need to overcome the "local" nature of technology innovation versus the "universal" nature of scientific invention (it has been observed that technology innovation, due to its many specific processes, is understood only by those who work very close to it, while scientific invention is understood by a large scientific community using the same mathematical language)
  -lack of a "technological gatekeeper," i.e., one who is well versed technically and well connected internally and externally to give decision-makers timely inputs
  -lack of a "boundary spanner," i.e., one who has been transferred between organizations and understands the values of both organizations
  -lack of understanding as a result of not recognizing the need to collaborate
  -over-differentiation and compartmentalization, which hinder flow of real information.

- Cost of gaining market acceptance is too high:
  -high initial startup costs and longer period before payback place new development projects at a disadvantage relative to minor extensions of present product projects
  -project acceptance is primarily based on benefits measurable in monetary terms, which does not include many intangible benefits
  -unclear market demand for the eventual by-products of innovation makes cost-benefit analysis difficult
  -unpredictability of innovation over course of development causes business plans to keep changing, driving up costs.

Origin of All Barriers. Upon closer examination of the barriers originated from behavioral and organizational culture, one can reason that the three primary barriers can all be traced to a fear of the unknown and a desire to avoid risk. The "threat barrier" looks at the innovation as a possible disruption to the existing order and fears the unknown of the new order if innovation succeeds. Naturally, the "risk barrier" is rooted in the fear of risk. The "reluctance barrier" can be shown to originate from a fear of the unknown. The "corporate policy," "strategy," "and management" barriers can be traced to a fear of losing the established order and efficiency. The "current market" barrier originates from a fear of losing highly efficient operation and established optimized order. The "lack of understanding," "lack of information," and "cost" barriers can all be traced to a fear of the unknown.

The primary barriers and possible corresponding origins are compiled into two categories: those originated from a fear of risk and the unknown, and those originated from a fear of loss of efficiency and order. Fear of the unknown, risk, loss of order, and loss of efficiency ultimately can all be traced to a single fear: the fear of change. The resistance to change exhibited by a large organization or any social system is nearly a form of dynamic conservatism; in other words, it is a tendency to fight to remain the same.

Solutions to Innovation Barriers

Ultimately, the solutions to innovation barriers must come from overcoming the fear of change, a subject of modern interest. One effective way to overcome fear of change may be the theory of the fifth discipline by Senge (1990a). Due to the limited scope of this present study, only empirically observed solutions are discussed below; however, their overall consistency with Senge's theory can be established.

Fostering a Creative and Intrapreneurial Climate. To create an innovator's creative environment, Martin (1984) gave several essential ingredients. These ingredients combined with Pinchot's (1985) description of a leader and Quinn and Mueller's (1963) policy toward a motivational environment are synthesized below:

- clearly state the vision of the company's future to focus employees' energy on creating innovation that directly relates to the strategy of the company
- convey clear perspective of creative person's role in the entire organization
- minimize barriers to intra- and interorganizational communications

- provide more autonomy to innovators and challenge them to produce timely, creative solutions
- replace ineffective controls by delegating more responsibility to one closest to customers
- look at every level for innovation, be receptive and responsive to individuals' ideas, and show interests, recognition, and appreciation of their efforts
- tolerate the productive nonconformist's style.

Pinchot (1985) derived 10 important freedom factors for an ideal intrapreneurial environment. Pinchot's freedom factors and Quinn and Mueller's (1963) policy for a motivational environment have been consolidated and simplified into the following eight elements. These elements can serve as a guide to encourage development of an ideal intrapreneurial environment:

- self-selection: intrapreneurs should be encouraged to appoint themselves to their role and receive the corporation's blessing for their self-appointed task
- self-determination: intrapreneurs should be allowed to carry out their mission and not be encumbered by remote decision-makers who may not understand the technical intricacies and market potential
- long-term discretionary resources: intrapreneurs should be given discretionary resources over a sufficiently long duration free of the attendant administrative over-analysis and over-control
- tolerance of risk, failure, and mistakes: mistakes, blunders, and false starts should be considered to be opportunities for learning.
- freedom from cross-functional barriers: intrapreneurs should be provided small, dedicated cross-functional teams with full responsibility and full access to company-wide interaction
- reward intrapreneurs with new career paths that fit their needs, and reward those responsible for sponsoring and implementing technological change
- educate managers that, during downsizing, the greatest opportunity lies in being intrapreneurs
- hands-on not hand-offs: the innovation process should involve cross-functional teams, but not handing-off to another team without seeing the commitment displayed beforehand.

Small Companies in a Large Company. Historical data (Martin 1984) indicate that small, young companies outperform large, mature companies in terms of ability to react to technological changes and to create increases in employment, in absolute terms. Specific features of the innovative organization, as summarized by Twiss and Goodridge (1989), are a clear vision, an orientation toward customer satisfaction, an orientation toward technology learning and experimentation, high organizational autonomy, constructive competitive spirit, high tolerance of the unorthodox, positive management of change implementation, and positive rewards for risk-taking innovation. Innovative organizations must therefore behave like the small entrepreneurial companies, yet take full advantage of the benefits of their size and resources. Understanding that innovation is a combination of innovators interacting with a challenging but supportive organization, Welch (1982) stated that his goal was to "reshape GE as a band of small businesses to take advantage of the strength of a large company and act with the agility of a small company."

Roberts (1968) noted the need for new forms of organizational incentives and managerial philosophies to retain and stimulate the would-be entrepreneur. Roberts and Frohman (1972) examined the role of intrapreneurship as a strategy for growth. They suggested the following approaches to promote intrapreneurship: recruiting or finding champions for new products and services, stimulating them toward entrepreneurial behavior, aiding them in developing business growth, separating them from the rest of the organization's product lines (or giving them freedom to

seek support from elsewhere in the firm), freedom from short-term pressures, different rewards, improved visibility, and access to the top. Roberts (1968) emphasized that the key success factor is clear evidence of the organization's conviction that an important element of its future rests upon successful replication, within the organization, of small-firm entrepreneurial patterns.

Boksjo and Delin (1991) believe the entrepreneurial spirit can inspire attitude and behavioral changes to overcome most of the organization's structural barriers. They suggest that the solution should be to saturate entrepreneurial spirit in every level of the organization by decentralizing the organization and promoting networking. Specifically, they suggest retraining managers to relearn abilities that were delearned within the organization, implementing idea-generating team-sessions, establishing screening criteria for new ventures, forming new venture teams, creating incentives and rewards, and utilizing mistakes and failures as learning tools. Consistent with Senge (1990b), these actions are partial solutions needed to transform an organization into a learning organization.

Twiss and Goodridge (1989) suggested the following initiatives to promote innovation: management shows clear interest in ideas for improvement at all levels; managers' security is measured in terms of innovation and change; creativity and innovation are included as key performance measures; the incentive system is revamped to encourage risk-taking innovation; and a "medal of defiance" is included in recognition of extraordinary contempt and defiance beyond the normal call of engineering duty.

The main challenges to top management are integrating the efforts of a number of visionary leaders, and balancing the needs, ambitions, and results of a small group of restless intrapreneurs with the need for corporate stability and efficiency. All these traits are necessary to be a learner, consistent with Senge's (1990b) learning organization hypothesis.

Attributes of Innovative Organizations. Peters and Waterman (1982) observed common characteristics of excellence among 43 of 62 highly regarded U.S. companies and summarized that companies that are successful in technological innovation appear to possess the following common traits:

- Shared core values that define the corporate culture:
  -many anecdotal stories helping to define, convey, and maintain shared values
  -sense of highly valued purpose
  -ability to extract extraordinary achievements from large numbers of people
  -culture that supports the priority attached to technological innovation.

- Creative environment:
  -people oriented
  -respect for individual and ability to achieve extraordinary results
  -creativity encouraged from all employees
  -not a hire-and-fire company.

- Customer-oriented:
  -obsessively concerned with quality, reliability, and service
  -tailoring products to specific market niches
  -simultaneously engaging in technology and market monitoring
  -technological planning is integrated with business planning.

- Well led but decentralized, with lean staff and simple form:
  -rigidly controlled and directed but at the same time encourages autonomous entrepreneurship and innovation
  -small independent groups
  -flexibility and fluidity maintained by frequent reorganizations of project teams, use of task forces, and innovative ventures.

- Stay in the technology-market segments within which they achieved excellence:
  -top management has technical backgrounds
  -know limitations.

Quinn (1979) summarized that achieving large-scale innovation would need the following elements: clearly defined need and shared common goal; strong incentive for successful development; promotion of multiple competing approaches and tolerate resulting chaos; user-customer orientation; technical excellence; long time horizon; rewards for innovation; and top-level risk-taking support. Arthur Young's (1985) survey compiled the following key elements for innovation management: continued top management commitment, clear-cut objectives and processes, reward systems for innovation efforts (for example, reward risk-taking and reduce fear of failure), and attention to customer needs. Edosomwan (1989) listed 10 traits of an ideal innovative manager, which can be summarized into following key elements:

- being innovative, creative, technically competent, and self-confident, exhibits strong desire for innovation; encourages others to come forward with new ideas; shows keen interest in progress.
- willing to take risks and encourages subordinates to do the same; accommodates failures as learning steps; rewards entrepreneurial behavior in timely way.
- being a people person, encourages a trustworthy working environment, supportive of employee contributions and ideas.
- delegates necessary control to person responsible for performing tasks, provides guidance as required.

There are no shortcuts to organizational innovativeness. As is discussed in greater detail in section 5, to promote innovation and intrapreneurship, many significant and complex steps need to be taken, some involving fundamental changes in culture, which may take generations to realize. Some specific and less-disruptive approaches, however, can yield visible results. Once implemented, and results become clear, such approaches eventually pave the way to a true innovative organization. The following are some approaches in this category:

- show clear evidence of the organization's belief that its future rests on successful replication, within the organization, of small-firm entrepreneurial patterns.
- use recruiting, hiring, and promotion criteria that include consideration of quality of intrapreneurship.
- provide quick and direct access to "seed money" for innovators and potential entrepreneurs. This will allocate limited funds earmarked for the exploratory investigation of new ideas to middle-level supervisors with minimum review and speedy approval.
- form multiple organization-sponsored teams for fostering and investing in new product ideas. Product teams include technical, development, marketing, and financial personnel recruited from within the organization and joined by a common commitment to the new product idea.
- establish an internal entrepreneurship (i.e., "intrapreneurship") program. This program should identify champions for new products, processes, and services. Then separate this program from the line organization to provide greater independence, freedom from short-term pressures, improved visibility, and access to top management.

3. Survey Methodology

Underlying Framework

The framework for this study's survey questionnaire was established from the conceptual building blocks discussed in the preceding section. Looking at only the major components, one can formulate a conceptual model describing the interrelationship among innovator, intrapreneur, barriers, and the changes necessary to transform innovation into competitive advantage. The complex interaction among forces that stimulate change—divergent-convergent thinking and creativity, origins of innovation barriers, organizational reaction and changes, and the innovation—is depicted in figure 3.1, which conveys the essence of the survey questionnaire. Changing environments exert external or internal forces that stimulate the organization to change. These forces stimulate tension between divergent and convergent thinking. An organizational climate that nurtures divergent and convergent thinking promotes sources of creative thinking that may evolve into inventions. The contrast between the values and norms of intrapreneurs and those of large organizations also create tension. This tension erects barriers and works as a sink of creative thinking. Two barriers result due to fear of the unknown and risk aversion, and fear of giving up efficiency and order. Both barriers are built on the fear of change. The few inventions that turn into innovations and eventually overcome barriers may be transformed into competitive advantages.

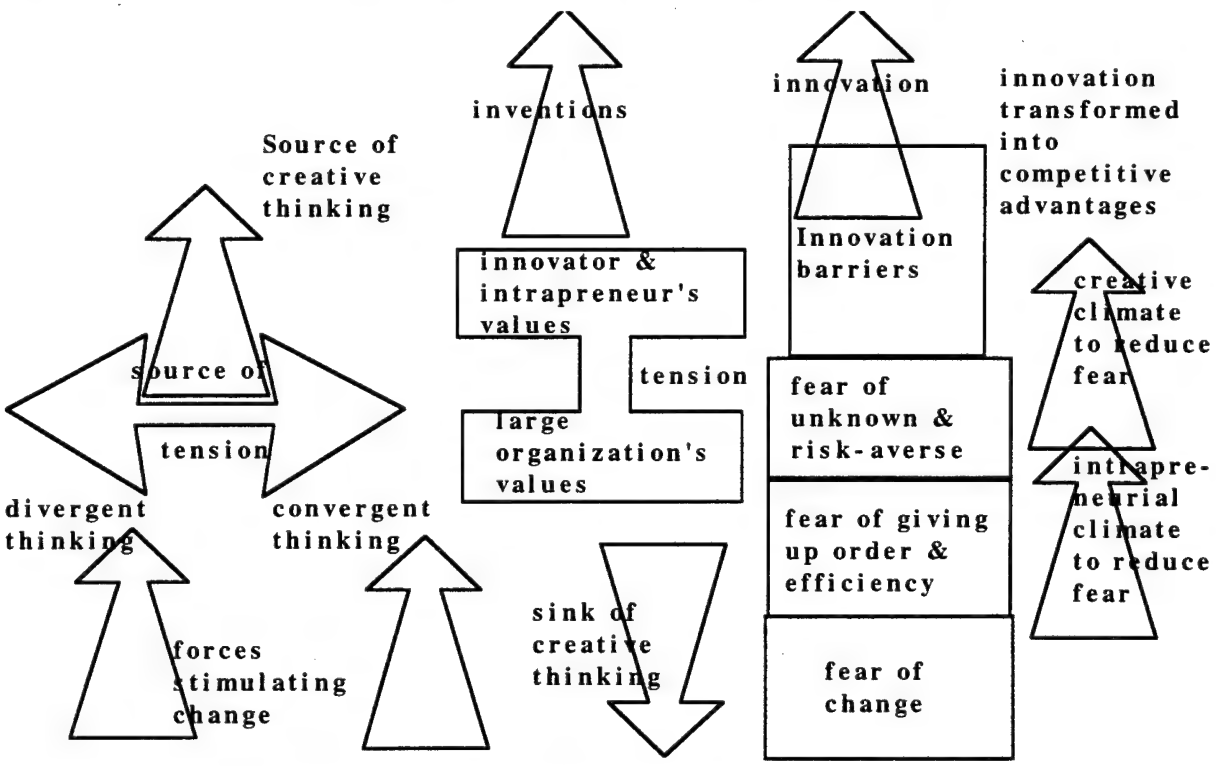

Figure 3.1 Conceptual Interrelationship Among Creative Thinking, Innovator, Intrapreneur, Origins of Innovation Barriers and Competitive Advantage

The embedded assumptions are that the primary components are those mentioned above; the time sequential order proceeds from invention to innovation to competitive advantage; the barriers originate from only two types of fear, and the most effective way to reduce barriers is to promote a creative and entrepreneurial climate. A creative climate will reduce fear of the unknown and risk. An entrepreneurial climate will help mitigate the fear of loss of order and efficiency. Both point to the need to reduce fear of change.

Although the simplifying assumptions made above are challengeable, the general framework is consistent with that of many published works. The goal of the survey questionnaire was to enhance our understanding of the dominant factors creating the innovation barriers.

Design of Questionnaire

The prioritized list of barriers to innovation and intrapreneurship was compiled and simplified, as summarized in section 2. This list was the basis of questions on barriers. All special terminology was removed and additional barriers were elicited from respondents. The objective was to establish a prioritized list from respondents so that it could be compared with the original list and to enhance its accuracy and completeness.

Questions of origins of barriers based on the list presented in section 2 were then listed. The objective was again to obtain a prioritized list of origins of barriers, and to allow correlation with the responses of both the innovators-intrapreneurs and the organization's management establishment.

Questions of possible solutions to overcome the barriers were formulated from the list presented in section 2, which is primarily based on Martin's (1984) and Pinchot's (1985) observations. The questions of possible solutions to innovation barriers were grouped into three major areas: how to foster a creative climate, how to develop an ideal entrepreneurial environment, and how to establish an intrapreneurship program. The responses to the questions were measured on a numerical scale to allow numerical correlation analysis.

Questions to innovators and intrapreneurs were based on the composite list discussed in section 2. All questions were designed to provide a numerical scale to measure the tendency of the respondents to be an innovator or an intrapreneur. Questions to organizational management were based on the composite understanding presented in section 2. All questions were designed to provide a numerical indication of the tendency of the respondents to be advocates of organizational values or norms.

Analysis Methodology

The survey responses were input into an Excel spreadsheet with each response to a question assigned a numerical value. The first step was to sum all the responses about the barriers. Then, the responses on the origins of each barrier were summed to obtain a prioritized list. The same thing was done for solutions to barriers. The results were presented in histograms, and the responses to the questions posed to innovators and intrapreneurs, and those posed to organizational management were plotted on a diagram to segregate the tendencies of respondents. The high-tendency respondents were categorized into two groups: innovators/intrapreneurs and status-quo establishment. Their responses about the barriers were plotted against each other (in histograms) to bring out the difference in perspective and were then compared with the common understanding of the difference in terms of the values and norms shown in section 2. The high-tendency group's responses were also correlated with published lists of attributes to confirm their accuracy. These results served as the basis for formulating an innovation enhancement prototype initiative, which is discussed in section 5.

The methodology steps are presented in the diagram shown in Figure 3.2.

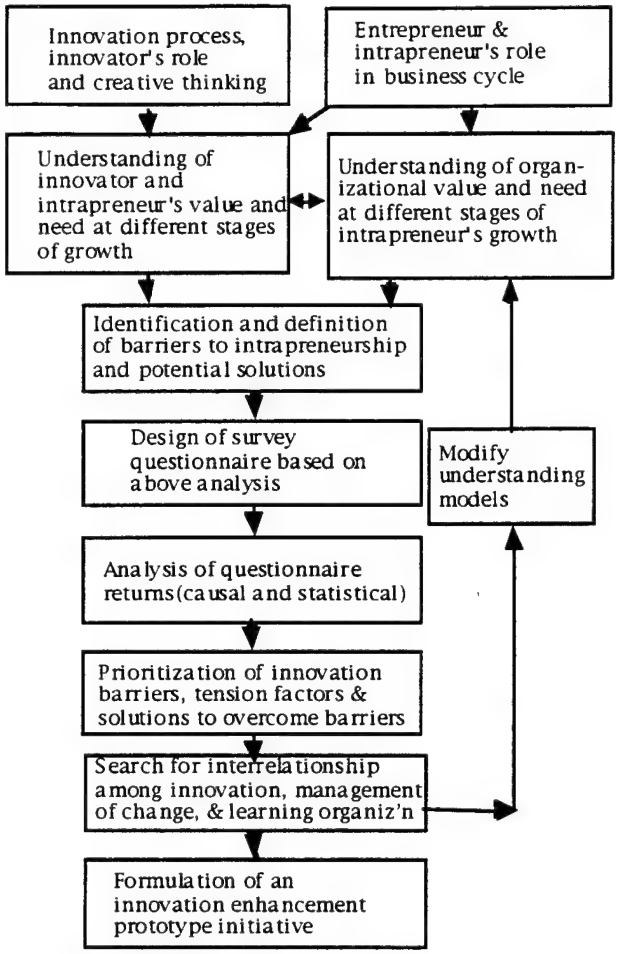

Figure 3.2. Flowchart of Survey and Analysis Methodology

4. Survey Results

In January 1994, 300 questionnaires were sent to a Navy technology and systems development organization, henceforth to be abbreviated as NTSL. Selection of recipients was based on the recommendations of 10 technical department heads. The intention was to obtain as random a distribution as possible in terms of recipients' educational level, years of service at NTSL, type of position, and importance of innovation to present job. A personalized cover letter to each recipient assured the confidentiality of the survey and reminded recipients not to reveal their identity on the questionnaire. The recipients were also informed that response to the questionnaire was entirely voluntary. By March 31, 1994, 125 responses were received, 6 of which were invalid and discarded. A total of 119 responses were entered into an Excel spreadsheet and analyzed using both the worksheet functions and analysis tools contained in the Excel program.

The respondents' backgrounds, including educational level, length of employment, level of responsibility, type of position, their view of the importance of innovation in their current job, and their tendency toward either entrepreneurship or maintaining the status quo were analyzed (see Meng, 1994). A discussion of statistical significance and of how the threshold values were obtained for the high-tendency groups is also given in Meng (1994).

Segregation of Respondents into High-Tendency Groups

Certain survey questions were designed to detect a high tendency toward intrapreneurship or toward advocating the status quo. The distribution of all responses in terms of the intrapreneur tendency indicator and status-quo indicator is shown in the intrapreneur/status-quo tendency map of Figure 4.1.

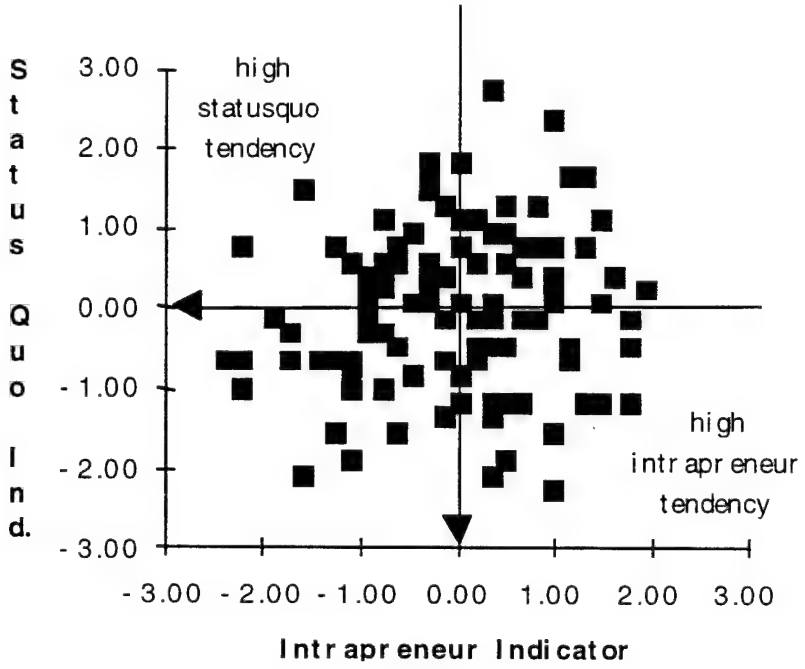

Figure 4.1. Respondents' Tendency on Intrapreneur/Status-Quo Indicator Map

As is shown in Figure 4.1, the 119 responses clustered around the center (0.,0.). The distribution has no particularly distinct pattern. It appears to be uniform throughout the entire map, without clear tendencies toward either intrapreneur or the status quo. This map suggests an obvious criterion to segregate intrapreneurs from those advocating the status quo. Responses having high-intrapreneur indicator value (i.e., those in the lower right quadrant) are defined as the high-intrapreneur-tendency group; 27 respondents were in this group. Similarly, those responses in the upper left quadrant are defined as the high-status-quo-tendency group; 26 respondents were in this group.

Summary of Survey Results

This section summarizes the survey's major results. For a complete analysis and interpretation of all survey findings, see Meng (1994).

Table 4.1 lists the prioritized innovation barriers identified from the survey results, along with the most probable underlying origin of each barrier, the tension factors of statistical significance, and needed approaches to remove each barrier. All of the tension factors are expected from the known contrast in norms and values discussed in section 2. It is important to point out that the survey found no exception to this tension factor expectation. Looking toward future, the last column of Table 4.1 lists the needed approaches to remove or correct innovation barriers, based on known practices of innovative organizations. The preferred approaches and another set of tension factors are summarized in Table 4.2.

TABLE 4.1. SUMMARY OF SURVEY FINDINGS

Prioritized Innovation Barriers (in descending order) and the Most Likely Origin of Each Barrier	Tension Factors Between Intrapreneurs and Status-Quo Group (innovation barrier origins identified by intrapreneurs that status-quo group disagreed with)	Approaches to Rectify Innovation Barriers
Predominant Commitment to Current Products -insufficient investment fund	-insufficient investment fund -focus too short term -lack organizational flexibility	-stable discretionary funding over a long period -formation of cross-functional teams
Reluctance to Enter New Fields -need to invest in facility and infrastructure	-need to invest in facility and infrastructure -perceived difficulty in obtaining top management approval	-clear vision of future -clear communications that innovations at all levels are crucial to long-term viability of organization
Inadequate Cross-Functional Understanding -over differentiation and compartmentalization	-lack opportunities for decision-makers to learn about innovation	-more opportunities for interaction with decision-makers
Cost of Gaining Market Acceptance Too High -high start-up cost	none—means agreement among respondents	none
Information Unavailable to Decision-Makers -inadequate internal communications	-inadequate internal communications	-reduce communications barriers
Risk of Failure -low incentives for risk-taking	-reflection of establishment's short-term view	-reward to entrepreneur risk-taking -acknowledgment of mistakes are part of learning
Threat to Individual Power Structure by the Proposed Innovation -innovation out of scope of organization charter	-expose organizational lethargy	-clear communications that innovations at all levels are crucial to organization

TABLE 4.2. PREFERRED APPROACHES AND TENSION FACTORS FOR FUTURE INNOVATION PROGRAMS

Future Innovation Programs	Preferred Approaches	Tension Factors* Between Intrapreneurs and Status-Quo Group
Fostering Creative Environment	-recognition and appreciation of innovation at all levels -clear vision of future -clarify innovator's role in organization's future -reduce communications barriers	-tolerance of productive nonconformists
Developing Entrepreneurial Environment	-hands-on not hands-off; cross-functional teams should move downstream with the innovation project -reward intrapreneur with recognition and growth career path -provide long-term discretionary funding with less administrative oversight -free from cross-functional barriers	-innovators' self-selection -innovators' self-determination
Intrapreneurship Program	-seed money to innovators; frequent use of cross-functional teams; establish a prototype intrapreneurship program	-hiring should consider entrepreneurial qualities

*Tension factors are innovation barrier origins identified by intrapreneurs that status-quo group disagreed with.

The survey questionnaire was built on a conceptual framework of the life cycle from invention to innovation to competitive advantage, and the basic building blocks of creative thinking, the contrast in values and norms between intrapreneurs and the status-quo group, and the fear of change. The survey results show that all tension factors, without exception, originate from the contrast in the values and norms of the two high-tendency groups. These contrasting differences can be traced to the fear of change. The theoretical framework presented in Figure 3.1 is therefore confirmed, although its validation will entail further analyses and empirical tests. The essence of the framework is presented in figure 4.2. The entire innovation barrier issue is related to the issue of management of change. This observation can be the basis for more structured analyses in the future.

The conclusions drawn from the survey results are the basis for designing an innovative organization, which is discussed in the next section.

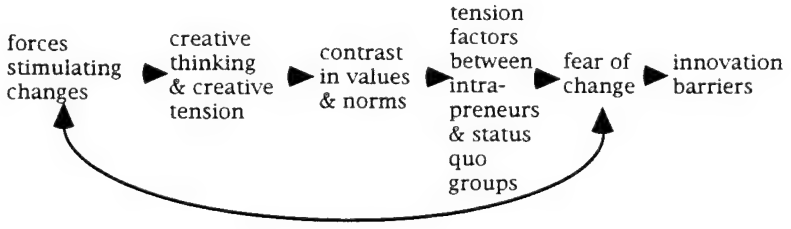

Figure 4.2. Simplified Schematic of Origins of Innovation Barriers

5. Toward an Innovative Organization—Theoretical Basis

Generating Technological Innovation

Roberts (1987) indicated that three dimensions—staffing, structure, and strategy—affect successful innovation. For staffing, Roberts (1981) suggested that there are five critical innovation roles: idea generator (or innovator), entrepreneur (or product champion), program manager (or leader), gatekeeper (or special communicator), and sponsor (or coach). Roberts dissected the second dimension—structure—into four elements: market inputs, technical inputs, output-focused organization, and output transfers. Concerning market inputs, he emphasized the importance of forging partnerships among research and development and marketing organizations to continually bring market inputs into innovation development. Discussing technical input, Roberts emphasized the ability to continually increase interaction among internal technical personnel, as well as to infuse ideas developed outside of the organization. Regarding output-focused organization, he indicated that the potential default condition of a matrix organization (functional-project) defeats its effectiveness. Regarding output transfers, Roberts stated that human bridges are the most effective transfer mechanisms, especially upstream and downstream transfers of people, which later became commonly known as the core competence carrier mobility (Prahalad and Hamel, 1990). As to the third dimension—strategy, Roberts (1983) cited Utterback and Abernathy's (1975) study that technology evolution tends to follow a three-phase pattern (fluid stage dominated by product innovation, transition stage characterized by process innovation, and specific stage featuring minor product and process innovations), and emphasized that each stage has different strategic implications. Long-term persistence and changes in management style and policies from traditional mainstream approaches are required for effective implementation. Von Hippel's (1977) observation of the distributed nature of sources of innovation added further insight into generating innovation. It is therefore considered here as a fourth dimension to be added to Roberts' three, as shown in Figure 5.1. Some specific solutions addressing each of the four dimensions are summarized below.

Staffing. In regard to recruiting and rewarding, Quinn (1979) concluded that the organization must recruit people who have both the necessary entrepreneurial outlook and the technical requisites. Once hired, these people must have goals that appeal to them and stimulate them, and their performance must be rewarded, including those who lead intended growth groups. Roberts and Fusfeld (1981) echoed the same idea. They pointed out that a common mistake is staffing the replacements on the basis of technical qualifications rather than on their ability to fill the needs of the vacated critical roles. Roberts and Fusfeld gave the further insight that staffing for effective innovation must be based on assessing the critical functions and roles; each type must be recruited, managed, and supported differently, offered different sets of incentives, and supervised with different types of measures and controls. The recruiting needs to identify not only the technical or managerial qualifications but also the critical function activities that the job inspires. Quinn (1979) suggested that to meet large-scale challenges ahead, the process must start at the very top of the organization; his criteria for leadership are similar to Edosomwan's (1989) list shown in section 2. Quinn's criteria for Roberts' and Fusfeld's five critical roles are summarized in the staffing row in Figure 5.1.

Structure. Maidique (1980) concluded that successful innovation requires a special combination of entrepreneurial, managerial, and technological roles, i.e., a network of roles as a function of the stage of development. In addition, radical technological innovation requires top management's participation, i.e., the executive champion. Recognizing that middle managers tend to add a conservative bias to proposals, these executive champions maintain direct communications with technical experts, thereby establishing a network to retain the spirit of innovation. However, an inherent disorder is produced by such direct interaction of the central sources of sponsorship with the proposing agents.

Promoting informality in communications and encouraging risk-taking by executive champions are effective paths toward an innovative structure. This is reinforced by Thamhain and Wilemon's (1977) study that ability to create personal enthusiasm for the work, along with open communications, fosters a climate high in motivation and project performance. Dougherty (1989) hypothesized that one dynamic to motivate a cooperative working relationship is a more outward-oriented focus, rather than one limited to the

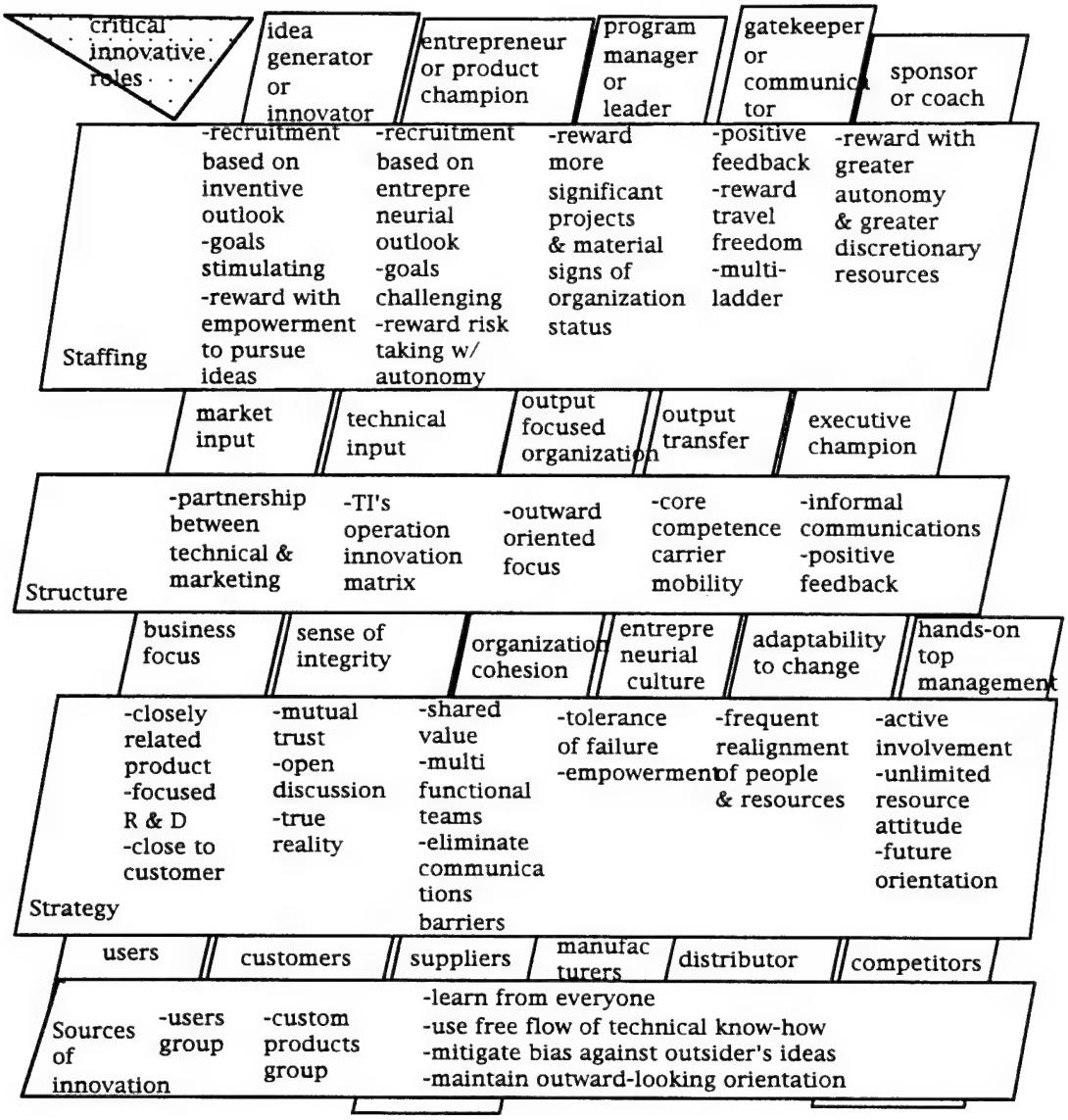

Figure 5.1. A Technologically Innovative Organization's "Fabric" (Based on Roberts and Fusfeld (1981), Quinn (1979), Haggerty (1979), Maidique and Hayes (1984), and von Hippel (1988))

usual departmental concerns. This outward focus not only tends to defuse interdepartmental behavioral resistance but also provides all participants with a sense that their concerns are being heard, which builds the sense of a common goal.

The innovation management task is to select and sustain, through the innovation process, inventions that offer the most promising innovative opportunities congruent with corporate goals and resources. To retain organizational vitality as the organization matures, it must build a capacity for innovation self-renewal, or a framework within which continuous innovation renewal can occur. However, the tendency is that as an organization matures, a greater premium is placed on administrative skills than on innovative skills. To rectify this tendency, Haggerty (1979) discussed Texas Instruments' Objectives, Strategy, and Tactics (OST) model, TI's long-range planning system, which is fundamentally a system of managing innovation. TI created a matrix organization—not functions versus projects but operations versus innovation management. Individuals within the operations matrix who are responsible for the objectives, strategies, and tactics collectively constitute the innovation management function. This system stimulates the generation, screening, selection, and evaluation of innovative ideas throughout the

organization. This approach institutionalized not so much a system but more an innovation culture.

To summarize these structural elements and their relationship with the staffing elements, Figure 5.1 shows that the partnership between the technical and marketing segments is woven into the market input, the outward-oriented focus is woven into the output-focused organization, the operation innovation matrix is woven into the technical input, the core competence carrier mobility is woven into output transfer, and informal communications and positive feedback are woven into the executive champion. From Figure 5.1, one can see more clearly the interrelationships that form the very basis of an innovative organization.

Strategy. Regarding resources planning, Quinn (1979) suggests a major attitude change toward long-term innovation investment. His suggestions include the "unlimited access" attitude to challenge the organization to produce high-quality ideas directed toward its goals and market needs regardless of cost, and revamping the whole planning process from a resource-rationing process into an opportunity-seeking process (e.g., the long-term strategy must override the return-on-investment or net present value ranking).

Maidique and Hayes (1984) focused on how innovative firms resolve a critical dilemma—the ability to manage the conflict between continuity and rapid change, in other words, how to unleash the creativity that promotes growth and change without being fragmented by it and how to control innovation without stifling it. Maidique and Hayes found six themes of success: business focus, sense of integrity, organizational cohesion, entrepreneurial culture, adaptability to change, and hands-on top management (as shown in Figure 5.1). The first three of these themes imply stability and order, while the second three are synonymous with rapid change. Business focus is built from closely related products, focused research and development, and consistent priorities through continuous, in-depth, informal interaction with customers. Adaptability to change is associated with frequent realignments of people and responsibilities to maintain balance on changing competitive factors. Organizational cohesion is achieved through building shared values and goals; eliminating interorganizational barriers, such as rotating managers across boundaries and through multidisciplinary project teams; tolerance of failure; long-term employment; and investment in employee development. A sense of integrity builds mutual trust and promotes free discussion. It also furthers understanding of self-limitation, thereby creating within the organization a true sense of reality. Hands-on top management is built through active involvement in the innovation process, receiving direct updates and cultivating the ability to ask direct questions. This interaction allows management to make rapid changes in the organization and in resource allocation. Burgelman (1984) discussed managing the internal corporate venturing process. He observed that the time scale mismatch of top management's 3- to 5-year tenure with the 8 to 12 years required for innovation contributed to the commonly observed severe oscillation in top management's interest and warned that unless the process is well managed innovation soon ends.

Sources of Innovation. Von Hippel (1977) found that successful designs for what later become successful products are sometimes available from customers or others before the manufacturer begins design work. He showed further evidence (von Hippel, 1988) that the innovation process is distributed across users, manufacturers, suppliers, and others versus the commonly believed manufacturer-as-innovator assumption.

Von Hippel hypothesized that the most likely source of innovation is dependent on the likely distribution of innovation-related "economic rents," i.e., innovations will be developed by those who expect the highest return. He found that innovative users, motivated by considerations of increased profits, have better equipment than their competitors. He also found that technical know-how flows uninhibited even among competitors. This observation clearly indicates the enhanced competitive advantage for outward-looking organizations. Furthermore, von Hippel showed the existence of conscious or unconscious bias against adopting the ideas or prototype concepts of outsiders. He suggested that custom product groups and user groups internalize ideas initiated from customers and users.

The key messages from sources of innovation are: learn from everyone, use the free flow of technical know-how, mitigate bias against outsider's ideas, and maintain outward-

looking orientation. With this, a complete innovative organization fabric is woven and is presented in Figure 5.1. One cannot help but wonder how difficult a task it is to build such an organization and to keep it innovative for decades.

Managing Fear of Change

Innovation favors promotion of a new order; i.e., change with its attendant informality and disorder is a necessary part of transition. On the other hand, established operations need consistency, continuity, integration, order, and efficiency. In today's competitive environment, the only constant is change; organizations are facing the challenge of maintaining a continuous balance between stability-reinforcing continuity and conflicting rapid changes. Schein (1993) indicated that organizations today are asked not only to change but also to change faster. As was identified in section 2 and in Figure 3.1, the fear of change is the origin of all innovation barriers; to overcome innovation barriers, one must understand and manage the fear of change, the fear of rapid change.

Schein's (1993) primary goal was to help organizations learn faster, to help them learn how to change and change faster. He proposed that there are two types of anxiety of learning. Anxiety 1 is the feeling associated with the inability or unwillingness to learn something new because it appears too difficult or disruptive. Anxiety 2 is the fear or guilt associated with not learning anything new. Schein suggested a three-step approach to manage the fear of change. The first step is to avoid creating anxiety 1; the organization must perceive that its current ways of doing things are no longer working. The second step is creation of anxiety 2, i.e., for change motivation to be aroused, the organization's members must discover that if they do not learn something new, they will fail to meet some of their important ideals. The third step is to make anxiety 2 greater than anxiety 1 through the creation of psychological safety. This last step involves providing a motive, a path, a direction, encouragement, support, and coaching to practice without fear of punishment. More specifically, it includes training and practice, rewards for innovative thinking and experimentation efforts in the right direction, even if efforts do not succeed, and legitimizing the making of errors by providing an error-tolerant environment. Note that these are the same attributes of an innovative organization discussed in section 2. Schein suggested the following steps to implement management of the change. First, the leaders must learn something new; leaders must overcome their own cultural assumptions and perceive new ways of doing things and new contexts in which to do them. Second, leaders need to create a change management group that must go through its own learning process to develop a culture that favors innovation and learning. Third, a specific continuous change program must be established and reinforced. These approaches appear to be similar to Haggerty's operation-innovation matrix organization, which was discussed earlier in this section.

In Mensch's (1979) study of innovations overcoming the depression, he found that major innovations occurred at a time highly correlated with the depression years. Major waves of innovation took place during the 1770s, 1830s (first industrial revolution), 1880s, and 1930s (second industrial revolution). These years corresponded to major world-wide economic stress or great depression, which presumably provided a powerful drive to stimulate drastic changes. This correlation may lend credibility to the theory by Schein (1993) that the fear of change can be overcome by a greater fear of not changing. Effectively changing an organization to outward innovative thinking can probably be more easily accomplished if this fear of change is recognized and managed.

Toward a Learning Organization

Learning Organization as a Source of Innovation. Problems of non-learning organizations have been observed by Senge (1990b). He noted that primary institutions of our society are oriented predominantly toward controlling rather than learning. As a result of not learning, a full one-third of the Fortune 500 industrials listed in 1970 had vanished by 1983; the average lifetime of the largest industrial enterprises is probably less than half the average lifetime of a person in an industrial society. Stata (1989) indicated that U.S. industry's most serious competitive problem lies in a declining rate of innovation and that this decline can be traced more to a lack of management innovation than to weak product or technology innovation. Table 5.1 summarizes Senge's definition of a learning organization, its attributes and how it differs from a non-learning organization.

TABLE 5.1. COMPARISON OF LEARNING AND NON-LEARNING ORGANIZATIONS

	Organization Characteristics	Traditional Organization	Transformed Learning Organization
Structure	construction	pyramid; tall vertical	flat; horizontal
	mode of operation	vision from the top down; centralized	team consensus; bottom-up; decentralized
	mode of command interaction	hub with spokes	network
	mode of learning	slow; immobile; long reaction time	fast; responsive; short reaction time
Leader-ship	style	authoritarian; rigid	egalitarian; flexible
	leader is viewed as a	hero; commander; visionary	designer; teacher; steward
	primary functions	set strategy and direction; make key decisions; energize troops	build shared vision; challenge prevailing mental methods; foster more systemic patterns of thinking
Manage-ment	focus	short-term events	long-term sustainability of competitive advantages
	approach	individual; non-systemic	collective throughout entire organization; systemic forces that shape systemic structure
	mode of learning	adaptive	generative
	impulse to learn	coping with a problem	creating and expanding capability
	motivation	extrinsic to solve problem	intrinsic to create creative tension
	scope	limited commitment	limitless; full commitment

Leadership's Role in Building a Learning Organization. Senge (1990b) set forth two leadership challenges on how to build a learning organization: new roles and new skills. In the new role of designer, the leader must design the governing ideas of purpose, vision, and core values by which all employees will live; must foster strategic thinking to enable an emergent phenomenon throughout the organization to craft a strategy; and must implement policies, strategies, and structures that translate guiding ideas into business decisions. In the new role of teacher, the leader must define reality to gain a more accurate, more insightful, and more empowering view of reality; must bring to the surface people's mental models of important issues; must reveal hidden assumptions of people's mental models; must restructure people's views of reality to see beyond the superficial conditions and events into the underlying causes of problems. Specifically, the leader should influence people to view reality at three distinct levels: events, patterns of behavior, and systemic structure. In the new role of steward, the leader needs to unleash people's impulse to learn by making them feel that they are engaging in an endeavor worthy of the fullest commitment, and needs to provide stewardship for the larger purpose of the mission. In regard to new skills in building a shared vision, the leader must encourage personal vision, communicate and ask for support, evolve vision as an ongoing process, blend extrinsic and intrinsic visions, and distinguish positive from negative visions. Concerning new skills of surfacing and testing mental models, the leader must see leaps of abstraction, must balance inquiry and advocacy, must distinguish espoused theory from theory in use, and must recognize and defuse defensive routines. In the new skill of focusing on systems thinking, the leader must see interrelationships—not separate processes and not snapshots, must move beyond problems, must distinguish detail complexity from significant dynamics, must focus on areas of high leverage, and must avoid symptomatic solutions and focus on fundamental solutions.

Core Competence as a Collective Learning Ability. Prahalad and Hamel (1990) defined the core competencies as the collective learning ability of the organization. Core competence is concerned with the organization's work and the delivery of value. Core competence is communication, involvement, and commitment to working across organizational boundaries. Core competencies are built through a process of continuous improvement and enhancement that span a decade or longer. In the short run, an organization's competitiveness derives from the price/performance attributes of current products. In the long run, competitiveness derives from an ability to build at lower cost and more speedily than competitors and to create products that customers need but have not yet even imagined (i.e., the core competencies that spawn unanticipated products). From this, one can extend the definition of core competence from that given by Prahalad and Hamel to "the collective learning ability of the organization and its ability to transform the learning results into the organization's competitive advantage."

The real sources of advantage are found in management's ability to consolidate corporate-wide technologies and production skills into core competencies that empower individual businesses to adapt quickly to changing opportunities. To achieve this goal it is necessary to articulate a strategic intent in a simple and instructive strategic architecture to the whole organization and the outside world. The resources should then be allocated accordingly; strategic alliances should be formed, and the organization should be configured to focus on core competencies.

The first step is to develop a corporate-wide strategic architecture that establishes objectives for competence building. A strategic architecture is a road map that identifies which core competencies to build and their constituent technologies. It should provide an impetus for learning from alliances and a focus for internal development efforts. The strategic architecture makes resource allocation priorities transparent to the entire organization. It yields a definition of the organization and the markets it serves.

The second step is to ensure the consistency of resource allocation and the development of an administrative infrastructure with the strategic architecture. The administrative infrastructure should make it clear that core competencies are corporate resources and may be reallocated by corporate management. "Core competence carriers" should be periodically assigned to cross-divisional projects to diffuse core competencies.

Interrelationship Among Innovation, Learning Organization, Managing Fear of Change, and Core Competence

Figure 5.2 proposes an overall interrelationship among innovation, learning organization, managing fear of change and core competence. Starting from the management of the fear of change, there is a clear causal relationship between overcoming fear of change and organizational innovativeness. Since the root origin of innovation barriers has been traced to the fear of change, by managing this fear (as described earlier in this section) the root barrier can be reduced, and so can the fear of the unknown and risk, as well as the fear of loss of order and efficiency. Once fear of change is managed, the fear of learning is overcome, so that a learning organization can proceed. One effectiveness indicator of a learning organization is its ability to generate creative tension, the essential ingredient of the innovation process, as was explained in section 2. Removing the barriers of innovation and increasing creative tension are both conducive to generating technological innovation as was depicted in Figure 5.1. Under the combined influences of innovation, learning organization, and ability to manage the fear of change, core competence will be generated—provided that the strategic architecture is articulated and resources are managed accordingly. This overall descriptive model provides an understanding of the interrelationship of all the major components in a consistent, coherent, and mutually reinforcing framework.

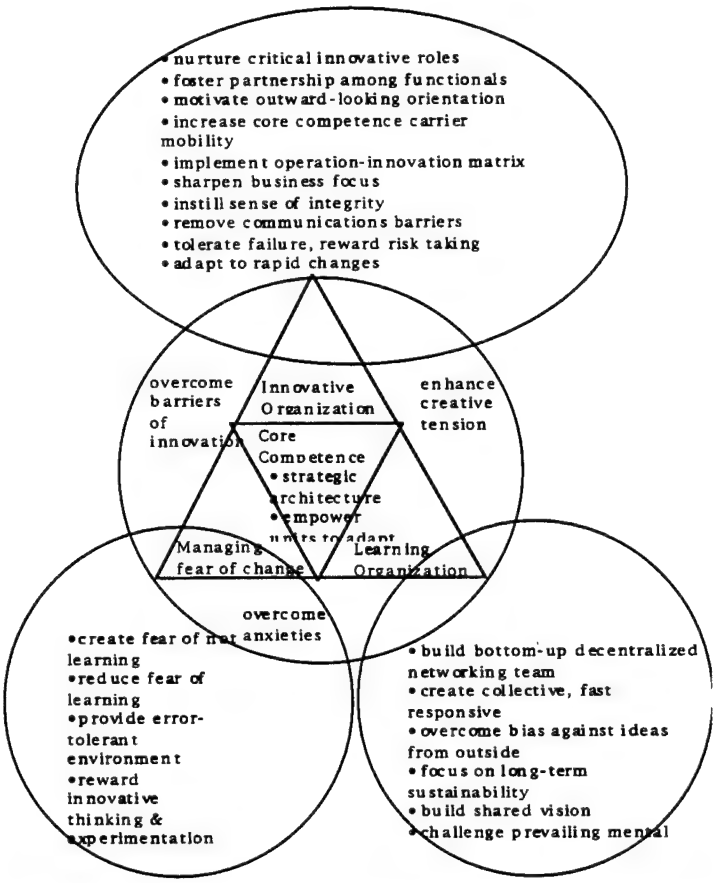

Figure 5.2. Interrelationship Among Innovation, Learning Organization, Managing Fear of Change, and Core Competence

6. Innovation Enhancement Initiatives—Practical Approaches

The goal of the innovation enhancement initiative is to mold the NTSL organization into a form that can foster more innovation and empower employees with more innovation management practices. This initiative includes three major elements: participative strategic planning, new integrated innovation programs, and a redesign of reward/performance evaluation systems. It is crucial to emphasize that the three elements cannot be separated from one another if the initiative is to be successful. An overview of the three elements is depicted in Figure 6.1.

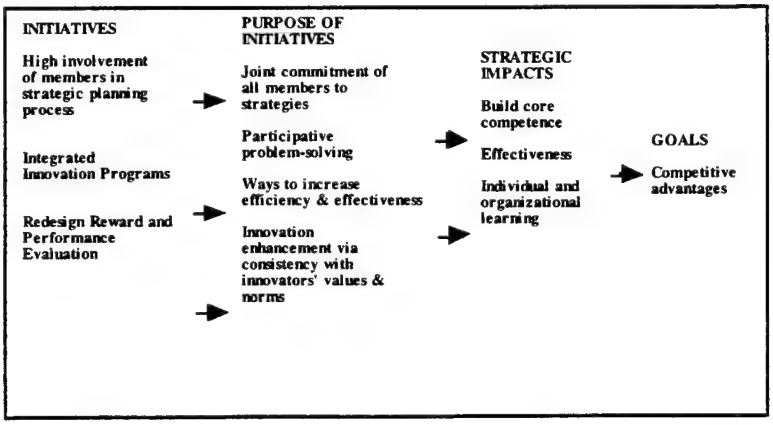

Figure 6.1. Purpose, Strategic Impacts, and Goals of Innovation Enhancement Initiatives

Defining the States

Peters and Waterman (1982) observed common characteristics of excellence among 43 of 62 highly regarded U.S. companies. They concluded that companies that are successful in technological innovation appear to possess the common characteristics presented in Table 6.1. These characteristics are defined to be the future state. The "NSTL Present State" column indicates whether or not NTSL meets each future state condition.

From Table 6.1, it can be seen that the key gaps are establishing a creative and entrepreneurial climate; empowering people closest to customers; decentralizing with fewer layers; and making more frequent use of reorganizations using multi-functional teams, task forces, and innovative ventures. The most difficult and time-consuming task will be decentralization. The intermediate transition state, therefore, should focus on the other three gaps.

Technology, which is one of the central foci of a Navy technology and systems development laboratory, could not operate at peak efficiency unless the needs of workers and the quality of their worklife are taken into account. Workers respond best and most creatively when they are given broader responsibilities, when they are encouraged to contribute, and when they are motivated to take satisfaction in their work. Currently, the NTSL organizational structure is hierarchical and centralized, with top-down decision-making and bottom-up execution. It carries some of the known syndromes of a traditional hierarchical organization, such as vertical and horizontal communications barriers. The challenge is to identify and implement the changes that will solve these problems without destroying the productive part of organization. The focus here is on introducing a participative strategic crafting process without changing the organizational structure.

To promote innovation and to encourage participative management performance, the reward and performance evaluation system must reflect both team efforts and innovators' values and norms. Currently, the reward and performance evaluation systems have a tendency to focus on visible results versus substance that builds core competence in the long run. It would be impossible to change the total compensation/reward system within the near future due to the very large organizational impact involved. However, the reward system is largely under local authority and can be changed to promote innovation and participative management efficiency. The focus here is on changing the reward system to reflect both team effort and innovators' values (viz., autonomy, public acknowledgment of achievement, discretionary funding, and opportunities to participate in future planning). These changes are also consistent with the participative management objectives.

Innovation Initiatives

One major lesson learned through the 1980s-1990s U.S. industry renaissance is the importance of full understanding and "ownership" by all employees of the organization's mission, vision, and strategic plan. If all employees do not operate daily according to the organization's strategic plan, it is tantamount to the organization having no plan. Achieving the understanding and ownership goal, however, is a long and tedious process involving many meetings and discussions. The purpose here then is to outline a simplified but effective process that ensures elimination of past mistakes and accomplishment of the employee ownership goals with minimal time and expense.

The first step is to introduce a self-explanatory outline for leading a group discussion through a step-by-step process to formulate the long-term strategy. This step is based on effective strategy crafting processes and lessons learned from a number of recent publications. The goal is to simplify the process into a number of discrete yet connecting steps that bring out the most crucial messages in discussion groups. Simplifying the process will encourage maximum participation by all members of NTSL. The most important outcome of this process is that all NTSL members will understand the severity of challenges ahead and they themselves will develop strategies to meet these challenges and put them into daily practice.

The second step is to devise a vision statement that reflects the NTSL mission statement, the needs of major business customers, employees' daily activities, and employees' professional growth goals, and then to discuss this statement with all managers. The vision statement must then evolve through iterative discussions and communications with all employees so that it is clearly understood and "bought into" by all employees. The

TABLE 6.1. CHARACTERISTICS OF TECHNOLOGICALLY INNOVATIVE COMPANIES

Shared Core Values That Define the Corporate Culture	NSTL Present State	Gap?
-create a sense of highly valued purpose	no	yes
-create ability to extract extraordinary achievements from large numbers of people	no	yes
-culture that supports the priority attached to technological innovation	yes	no
Creative Environment		
-people oriented	yes	no
-respect for individual & ability to achieve extraordinary results	yes	no
-creativity encouraged from all employees	no	yes
-top-level risk-taking support	yes	no
-reward innovation	not entirely	yes
-multiple competing groups	yes	no
Customer-Oriented		
-obsessively concerned with quality, reliability, and service	yes	no
-tailoring products to specific market niches	yes	no
-simultaneously engaging in technology and market monitoring	yes	no
-technological planning is integrated with business planning	yes	no
-empower persons responsible for performing tasks	no	yes
Organization Structure		
-decentralized with few layers, lean staff, and simple form	no	yes
-rigidly controlled and directed but at the same time encourages entrepreneurship	no	yes
-aggregated small independent groups	yes	no
-flexibility and fluidity maintained by frequent reorganizations using cross-functional teams, task forces, and innovative ventures	not enough	yes
-stay in the technology-market segments within which they achieved excellence	yes	no
-top management have technical backgrounds	yes	no
-know own limitations	yes	no

vision statement must then be prominently displayed as a guiding principle for all NTSL operations.

The flowchart in Figure 6.2 shows the overall sequence of events for construction of major elements of the strategic plan. It starts with mission, vision, and strategic goals and proceeds to implementation. The first iteration should be completed by department and division heads to focus the attention of a much larger team discussion in the second iteration. The second iteration should include all employees chaired by division heads. The third iteration is to be completed by department heads and directorate heads only.

The output of this process will be a brief document from each department, the first page of which describes the mission, vision, and strategic goals. The second and third pages describe the external and internal appraisals. The fourth page lists the critical success factors, core competencies that NTSL possesses, and gaps identified from product profiling. The fifth page describes the strategy and a milestone chart for strategy implementation. This document will then be used to conduct second-iteration discussions with all members to build understanding and ownership. The document will be improved through the process; it will be consolidated and condensed into the NTSL Strategic Plan and then promulgated.

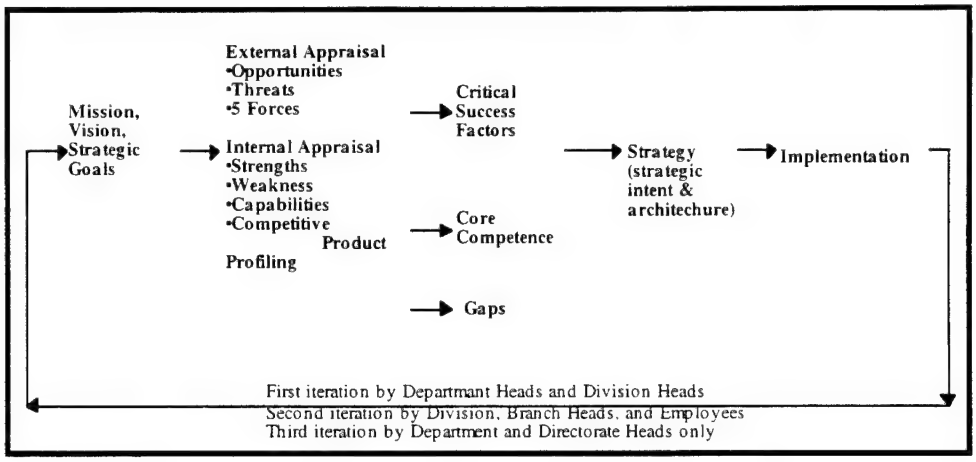

Figure 6.2. Strategy Plan Flowchart

Initiation and Implementation of Integrated Innovation Programs

Currently, NTSL innovation programs are drawn from four different sources without specific formal linkages among them and without explicit customer involvement. The present program interaction mode and feeder structure is described in Figure 6.3.

In general, this initiative and feeder system has worked well in the past when discretionary funds were available to investigate unforeseen problems. However, this system has several deficiencies. First, there are no formal linkages among funding sources, and it is usually difficult to cross between different sources of funding. Thus, either all of the gaps won't be identified or all of them will be identified but all won't be rectified. Second, programs or projects funded by the feeder funding sources are not always acceptable by the programs to be fed, creating orphan projects having good technical results but no place to go. Third, since process innovation is tedious, providing only small incremental gains, emphasis is on product innovation versus process innovation. Fourth, the few funding sources available, the low success rate, and personality conflicts accumulated over the years eventually discourage innovators from bold, innovative undertakings.

To rectify some of these shortcomings, the following is a step-by-step description of an integrated approach to initiate and implement an innovation enhancement program. These steps are based on the principles given by Roberts and Frohman (1972) and Roberts (1988).

1. Publish innovation needs: this includes articulation of mission, vision, and critical goals. In addition, specific areas of concern and measurable goals should be specified to clarify the degree of severity. This announcement should be a part of top management's communications and commitment.

2. Form teams: to ensure the preservation of entrepreneurship, team formation should be a self-selection process. All employees should receive a copy of the request for proposals. To encourage team efforts, higher priority should be given to cross-functional teams that go beyond organizational boundaries. Members of the team-forming group should seek advice and recommendations from management, but team members should make independent decisions about their team makeup. Management attention should be focused on ensuring that all critical roles as described by Roberts and Fusfeld (1981) are included. Certain duplication will be inevitable, and it may actually be healthy as it might stimulate competition.

3. Review proposals: the proposals should be prepared by team members in an informal process. The request for proposals should call for proposals to be categorized according to the matrix shown in Figure 6.4, where the various purposes, deliverables, goals, sponsors, and innovation programs are listed, along with their durations. The proposals are to be carefully separated. Innovation proposals that may have relevant inputs to various programs will be cross-referenced to stimulate cross-functional,

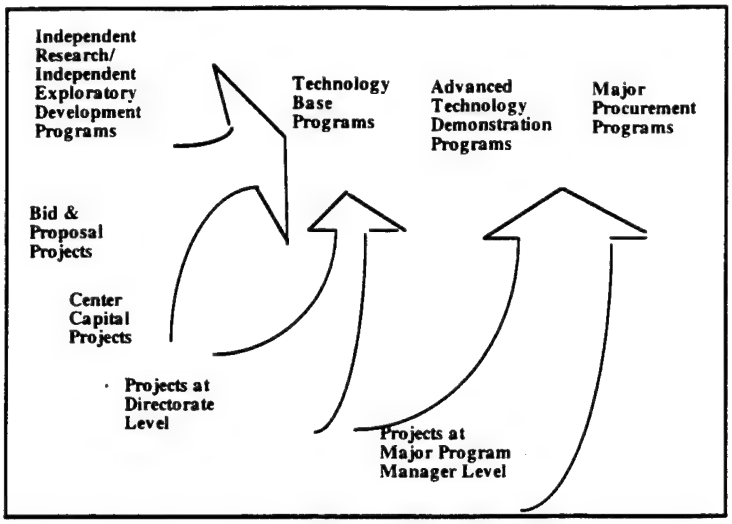

Figure 6.3. Current Innovation Project Feeder System Flow Diagram

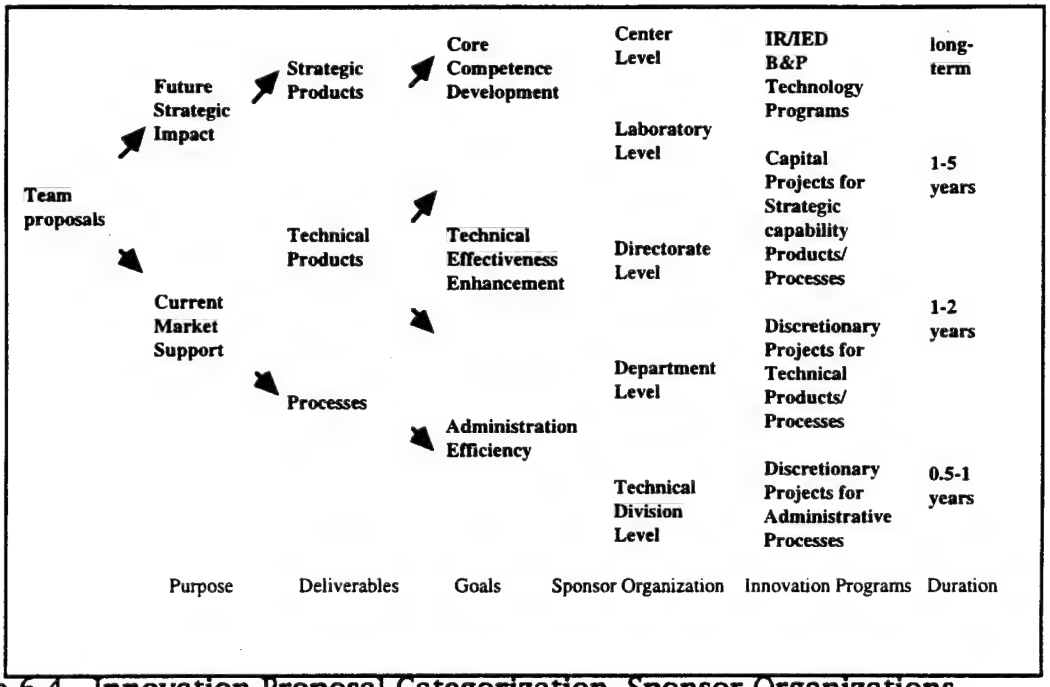

Figure 6.4. Innovation Proposal Categorization, Sponsor Organizations, and Programs

cross-program interaction and further team consolidation. The result will be increased cooperation, joint sponsorship, and synergy. People working in different organizations and programs can provide more timely and relevant inputs to one another constructively to mutually enhance each other's programs.

To accomplish the synergy goal will require strengthening the formal procedure to not only increase flexibility but also to encourage more informal dialogue. Such a task seems to be contradictory. No formal procedure can be so all-encompassing as to be foolproof; only a clear understanding by all participants of the need for networking of knowledge, keen perception of changing trends, and rapid adaptation by the main workforce can achieve the intended results. Given these caveats, the proposed planning and review cycle is depicted in Figure 6.5. Note the involvement of customers in reviewing the innovation proposals.

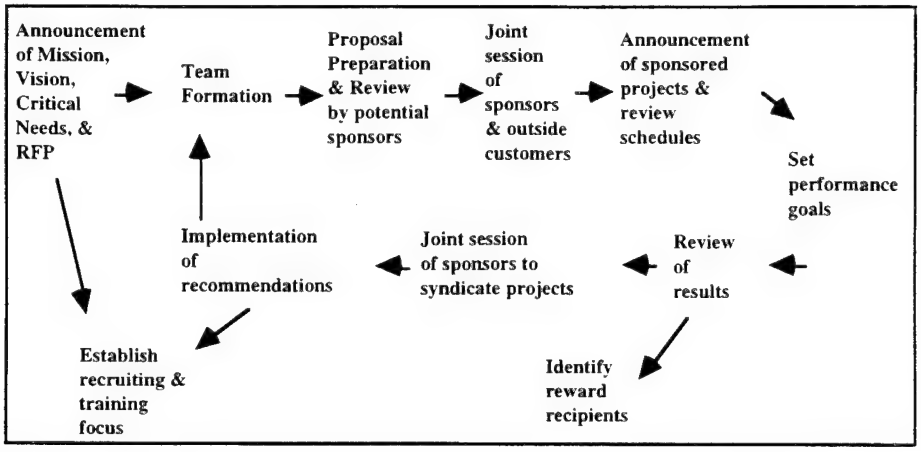

Figure 6.5. Flowchart of Innovation Program Initiation and Implementation Processes

program interaction and further team consolidation. The result will be increased cooperation, joint sponsorship, and synergy. People working in different organizations and programs can provide more timely and relevant inputs to one another constructively to mutually enhance each other's programs.

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Although only a few high-level key links are indicated in this flowchart, close linkages with personnel recruiting, setting performance goals, and reward and performance evaluation criteria are obvious. To successfully implement this procedure, close adherence to the open network principle is mandatory.

Reward/Performance Evaluation System for Innovators and Entrepreneurs

Technical professionals and innovators are the most expensive investment any R&D organization makes. Management of human resources lies at the core of the management of innovation; therefore, a reward/performance evaluation system is the heart of human resource management.

Innovator's and entrepreneur's values, needs, and growth patterns versus the organization's values and needs have been extensively analyzed and presented in section 2. In addition to equitable tangible compensation, the rewards must include: autonomy with challenge (i.e., empowerment to act, innovate, take risks to achieve high goals); flexibility (i.e., trust and commitment to explore, learn, and adapt); and future-orientation (i.e., opportunities to be involved in the strategic planning process). These understandings are now well established in the literature. However, a practical reward system has not been treated. The focus here is to apply our understanding of what is important to innovators and intrapreneurs to establish links between reward systems and innovators' and intrapreneurs' values. Special emphasis must be placed on reward and performance evaluation criteria, and a new evaluation/reward system must be designed based on principles developed by theorists and supplemented by some aspects of existing systems.

Kohn (1993) emphasized that extrinsic rewards have drawbacks, and he pointed out the need for increasing intrinsic motivation, self-direction, mutual goal-setting, and advancement training. Badawy (1989) summarized what an effective motivational system

must be based on: it should offer open opportunities for advancement, and it should focus on differences among individuals, such as background, skills, job context, career stage, and other personal attributes. Badawy also indicated the key elements of an effective performance evaluation principle to be: decomposing duties into separate tasks, mutual goal-setting, congruent value and professional judgment, and joint development of an advancement plan for skills, knowledge, and business performance. In short, building a close partnership between individual employees and the organization is the foundation of an effective system.

Based on the foregoing discussion and the expectancy theory model of Lawler (1981), the reward/performance evaluation system should be redesigned. The major components should be built around the values and norms of the innovators/ intrapreneurs and elements of the expectancy model. Both intrinsic motivational and extrinsic rewards and incentives should be included. The reward system must reflect less the formulas of job evaluation than the heightened importance of group achievement, and the expanded scope of individual contribution and growing concern for equity as gain sharing. The reward should be modified, beyond the above elements, to link to skill and knowledge improvement and goal accomplishment. The current trend that fewer supervisors are now required so that fewer promotional opportunities will exist for employees will be resolved by establishing multiple and different rewards. These proposed changes are summarized in Figure 6.6.

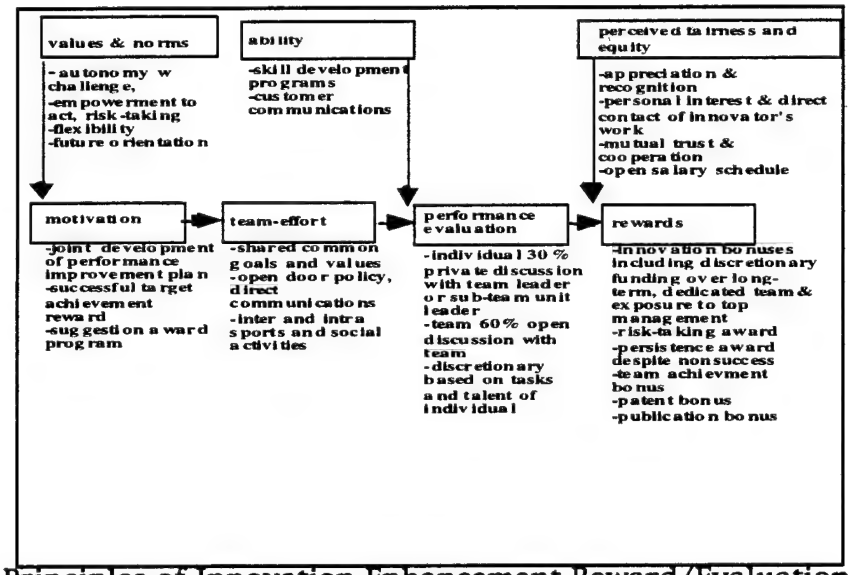

Figure 6.6. Principles of Innovation Enhancement Reward/Evaluation Initiative Based on Lawler's (1981) Expectancy Theory

The values and norms of innovators give them an intrinsic motivation, while the achievement reward and suggestion award programs stimulate employees' extrinsic motivations. Given the ability of individuals and teams, the team effort should be built on shared common goals and values, open communications, and camaraderie. Performance should be based on both individual and team effort achievements. Public recognition and appreciation of innovators' efforts, along with open salary schedules and the personal interest of top management in individuals' efforts will provide a perception of fairness and equity. The reward system should be based on both tangible achievements and intangible qualities such as risk-taking and persistence efforts. No reward, however, will be more valuable to employees than the daily interest, attention, recognition, and appreciation expressed by management.

As Figure 6.6 indicates, the reward system must be rethought and redesigned from the total expectancy perspective. Redesigning one aspect without changing the others will not achieve the objective, nor will it be considered an incremental improvement, since conflicts with values and norms may result. In fact, redesigning the reward and performance evaluation system is the most difficult of the three proposed programs. Therefore, these changes should be developed by the entire team over the time period of change and they should be improved on as the process goes along.

7. Conclusions

The major results of the survey are threefold. First, seven major barriers to innovation have been identified and prioritized. Second, the most likely origins of each innovation barrier have been identified. Third, tension factors that may cause the innovation barriers have been identified. These findings are useful for any large organization interested in enhancing its rate of innovation.

The prioritized list of innovation barriers and each's most likely origin are summarized here in descending order of significance:

- predominant commitment to current products due to insufficient investment funding,
- reluctance to enter new fields due to need to invest in facility and infrastructure,
- inadequate cross-functional understanding due to over- differentiation and compartmentalization,
- cost of gaining market acceptance too high due to high startup cost,
- information unavailable to decision-makers due to inadequate internal communications,
- risk of failure due to low incentives for risk-taking,
- threat to individual power structure by the proposed innovation due to the fact that innovation is out of the scope of the organization's charter.

The fact that the "risk of failure" and the "threat to individual" barriers are rated to be the two least significant barriers may be a reflection of the NTSL culture and the innovation-interest sample.

Tension factors between the intrapreneur group and the status-quo group are the major origins of innovation barriers that intrapreneurs have identified but with which the status-quo group strongly disagrees. Tension factors in descending order are:

- insufficient investment fund,
- lack of organizational flexibility,
- overstated need to invest in facility and infrastructure,
- overstated perceived difficulty in obtaining top management approval,
- inadequate internal communications,
- reflection of establishment's short-term view,
- exposure of organization's lethargy.

All of the tension factors can be traced to the contrast in values and norms between innovators and the status-quo group, thus confirming the real need—no longer a theoretical expectation—for management to attend to this contrast. Establishing this causal relationship is the most important result of this study.

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